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FRANCIS BACON.

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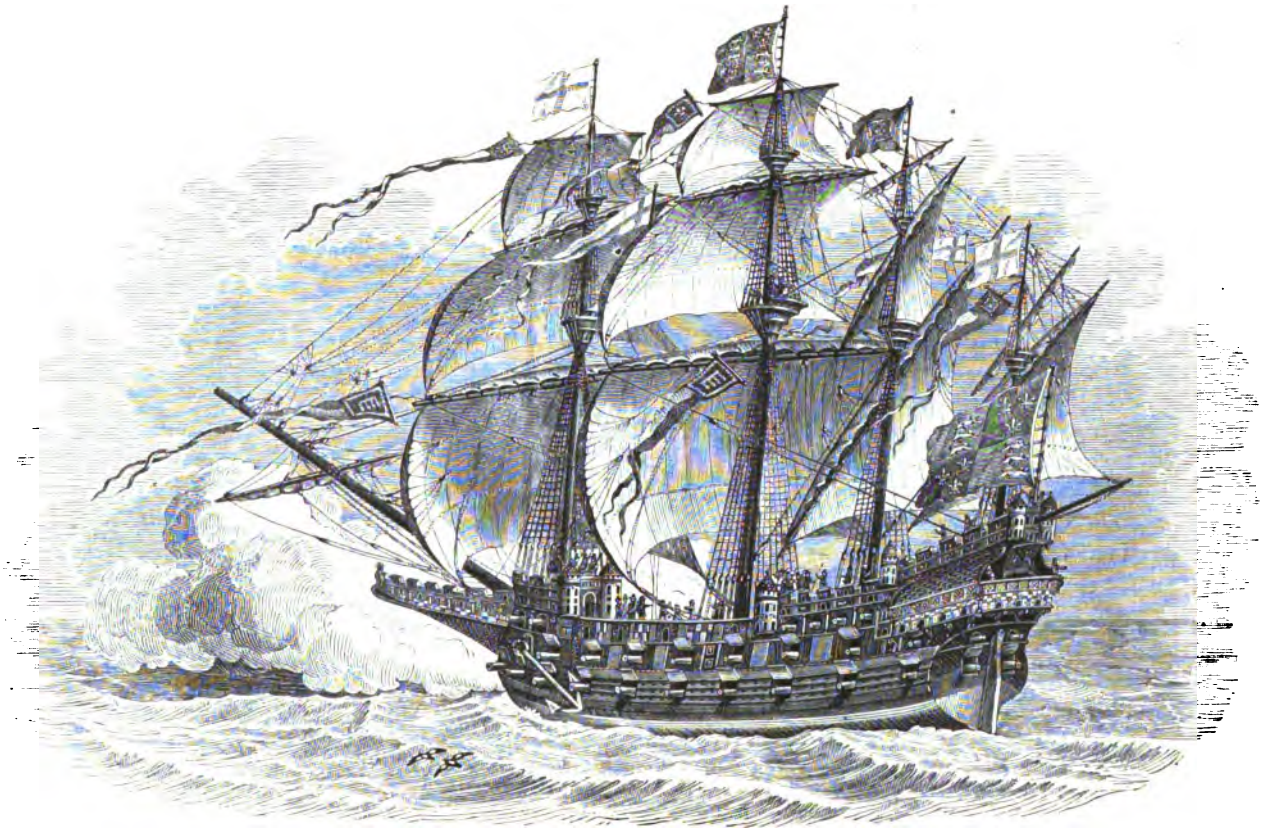

THE GREAT HARRY, AFTER HOLBEIN. (See p. 56.)

THE

WORKS

OF

FRANCIS BACON,

BARON OF VERULAM, VISCOUNT ST. ALBAN,

AND

LORD HIGH CHANCELLOR OF ENGLAND.

COLLECTED AND EDITED BY

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AND

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BARRISTER-AT-LAW: LATE FELLOW OF TRINITY COLLEGE, CAMBRIDGE.

VOL. II.

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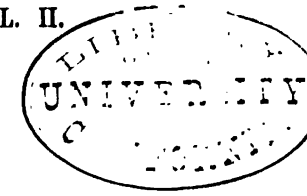

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HISTORIA VENTORUM.

PREFACE

TO THE

HISTORIA VENTORUM.

BY ROBERT LESLIE ELLIS.

THE *Historia Ventorum* was published in 1622 in a volume entitled "Historia Naturalis et Experimentalis ad condendam Philosophiam; sive Phænomena Universi." This volume was dedicated to Prince Charles, and contains beside the *Historia Ventorum* the titles of five similar histories, one or more of which Bacon proposed to publish month by month; namely, the Historiæ *Densi et Rari; Gravis et Levis; Sympathiæ et Antipathiæ Rerum; Sulphuris, Mercurii, et Salis;* et *Vitæ et Mortis.* Under the title of each, except the last, is placed an aditus or preface—that of the *Historia Vitæ et Mortis* is omitted because, as we are told at the end of the volume[1], the history itself with its preface was shortly, "jam proxime," to be published. It did not however appear until 1623.

The *Historia Ventorum* is thus the first published part of the *Historia Naturalis*, which was to be the third division of the *Instauratio.* It begins with a list of topics, or subjects to be inquired into. Of these thirty-three are enumerated, and some-

[1] "Aditus ad hanc historiam invenitur in historia ipsa, jam proxime sequente." But this comes from Dr. Rawley's reprint, published along with the *Opera Moralia et Civilia* in 1638, from which Mr. Montagu's copy is taken; and "jam proxime sequente" merely means "which is the next piece in this volume." The original edition, published by Bacon himself in 8vo in 1622, has the aditus to the *Historia Vitæ et Mortis* as well as the rest.

The *Historia Ventorum* appears to have been published about the beginning of November, 1622; the *Historia Vitæ et Mortis* about the end of the following January. See Chamberlain's letter to Sir D. Carleton, 11. Feb. 1622-3 (*Court and Times of James I.* vol. ii. p. 362), and compare Bacon's letter to Buckingham, 24th (misprinted 4th in the common editions) of November, 1622. — *J. S.*

thing is said in the course of the work with relation to each, but they are not all discussed fully, nor in the order in which they are set down. Bacon concludes the list by remarking that without more complete knowledge of the phenomena, some of the questions which he proposes cannot be answered. "Posteri," he concludes, "cætera videant."

The principal sources from which Bacon compiled the statements which he goes on to give are Pliny's Natural History, Aristotle's Problems, and Acosta's History of the Indies. Almost the whole of the sections on prognostics, which is one of the most complete, is taken from the eighteenth book of Pliny. A number of scattered remarks come from the twenty-sixth section of the problems, the most remarkable being the statement that on the top of Athos there is always an absolute calm —so much so that letters traced in the ashes of the sacrifice performed there year by year were always found, on each succeeding occasion, undisturbed. He adds that this is also told with respect to Olympus. His authority for this addition to what Aristotle had said may have been Solinus; or Alexander Aphrodisiensis as quoted by Olympiodorus. Perhaps, however, he took it from Giordano Bruno, by whom the windlessness of the summit of Olympus is mentioned in the Cene di Cenere.

Acosta, who was provincial of the Jesuits in Peru, published in 1589 his *De Naturâ novi Orbis* which contains an account of the climatology of America, and especially of Peru. In the following year he published a larger work, entitled "Historia Natural y Moral de las Indias," of which the first two books are a translation of the *De Naturâ novi Orbis*. This second work seems to have become very popular—it was translated into Latin, French[1], Italian, and German.[2] Most of the statements which Bacon derives from Acosta may be found in the *De Naturâ novi Orbis*, but there are some which show that he used the *Historia Natural y Moral* either in the original or in some translation.

Acosta's account of the climate of Peru is very favourable, and he speaks largely of the winds by which the heat of the sun is so pleasantly tempered that, as he affirms, the climate is more agreeable than that of Spain. He mentions the fine mist by

[1] The French translation by Regnier was published in 1600. It is singular that it is not mentioned by Antonio *Biblioth. Hisp.*, who enumerates the other translations.

[2] There is also an English translation by E. G. published in 1604.—*J. S.*

which the want of rain is supplied, but does not seem to have been aware of its cause.

Both in the following work, and in the *De Fluxu et Refluxu Maris*, Bacon cites Acosta by name in most of the places in which he takes anything from him.

There are several passages in the *Historia Ventorum* which show that Bacon had read William Gilbert's *Physiologia Nova*, which was not published until 1653. The history of this remarkable book is obscure. It was prepared for publication by the author's brother, who was also called William Gilbert, and he prefixed to it a dedication to Prince Henry. It would seem therefore that it was ready for publication in 1612, in which year the Prince died. Probably his death was the cause of its remaining unpublished, and it is possible that not long afterwards it came into Bacon's hands. Two copies of it, both imperfect, were among the papers which Sir William Boswell, sometime English minister in Holland, gave to Isaac Gruter; and from them the work was published in 1651. Gruter says nothing of the way in which Boswell had become possessed of them, but in his preface to the tracts and fragments of Bacon's which he published two years afterwards, and which he had also received from Boswell, he mentions that these had been bequeathed to the latter by Bacon himself. It is not improbable that the copies of Gilbert's work were included in this bequest or gift, which consisted of a fragmentary and miscellaneous collection of papers. However this may be, Gruter remarks in the preface to the *Physiologia Nova*, that it is clear that certain eminent men had had access to it while it was yet unpublished — plainly alluding to Bacon, to whose *Historia Ventorum* he has once or twice given marginal references. The way in which the remark is made seems to intimate that Gruter thought the use which Bacon has made of Gilbert's unpublished work was more or less unfair. It is therefore well to point out that in the *Novum Organum* Bacon cites Gilbert by name, commending an opinion which is expressed in the *Physiologia Nova*, and which cannot be found in the *De Magnete*; whence it appears that his not mentioning Gilbert's name in connexion with what he takes from him in the *Historia Ventorum* is only the result of his common habit of omitting to cite his authorities, and not of a wish to conceal the fact of his having access to Gilbert's unpublished writings.

A comparison of the *Historia Ventorum* with the *Physiologia Nova* enables us to correct, in more than one case, the received readings.

Gruter remarks that he is unable to decide whether the *Physiologia* was written before or after the treatise *De Magnete*, published in 1600. It was apparently written before 1604, as the new star of 1572 is mentioned by itself, whereas later writers, as Bacon and Galileo, always couple it with the star in Ophiuchus first seen in 1604. I should be inclined to conjecture that it was written between 1600 and 1604, principally on the authority of Bacon's remark, "Gilbertus postquam in contemplationibus magnetis se laboriosissime exercuisset, confinxit statim philosophiam consentaneam rei apud ipsum præpollenti;"[1] which is not however altogether conclusive.

The description of a first-rate man of war is one of the most curious parts of the following treatise.[2] I am inclined to believe that Bacon takes a portion of what he says of naval matters from some Italian writers, but cannot refer to any particular work. What is said of windmills seems to be derived from Bacon's own observation and experiments; it cannot be said that it is of much value. Between the vanes, according to Bacon, the air is compressed, and therefore reacts laterally. It did not occur to him to try whether a windmill with one sail only instead of four would remain stationary, as on his theory it plainly ought to do. On the other hand, he increased the number of vanes, thereby decreasing the intervals between them, and finding that this change increased the action of the wind, ascribed the difference to the increase of compression caused by the narrower space through which the air had to pass. That the whole amount of surface exposed to the wind was increased seems to have been forgotten.

[1] Nov. Org. i. 54.

[2] For an illustration of which see the frontispiece to this volume; which represents a first-rate of Henry the Eighth's time, and agrees with Bacon's description in every thing except the construction of the bolt-sprit. It is a reduced copy of an engraving said to be after an original by Holbein.—*J. S.*

FRANCISCI

BARONIS DE VERVLAMIO,

VICE-COMITIS SANCTI ALBANI,

HISTORIA NATVRALIS ET EXPERIMENTALIS

AD CONDENDAM PHILOSOPHIAM:

SIVE

PHÆNOMENA VNIVERSI:

QUÆ EST INSTAURATIONIS MAGNÆ PARS TERTIA.

LONDINI:

IN OFFICINA IO. HAVILAND, IMPENSIS MATTHÆI LOWNES ET GULIELMI BARRET.

1622.

ILLUSTRISSIMO ET EXCELLENTISSIMO PRINCIPI,

CAROLO,

SERENISSIMI REGIS IACOBI FILIO ET HÆREDI.

Illustrissime et Excellentissime Princeps,

PRIMITIAS Historiæ nostræ Naturalis celsitudini tuæ humillime offero. Rem mole perpusillam, veluti *granum sinapis;* sed tamen pignus eorum quæ Deo volente sequentur. Obstrinximus enim nos ipsos tanquam voto, singulis nos mensibus ad quos Dei bonitas (cujus agitur gloria tanquam in cantico novo) vitam nostram produxerit, unam aut plures ejus partes, prout fuerint magis aut minus arduæ aut copiosæ, confecturos et edituros. Moti etiam fortasse erunt alii nostro exemplo ad similem industriam; præsertim postquam penitus perspexerint quid agatur. Nam in *Historia Naturali* bona et bene instituta claves sunt et scientiarum et operum. Deus celsitudinem tuam diu servet incolumem.

Celsitudinis tuæ servus humilis et devotus,

FR. ST. ALBAN.

TITULI HISTORIARUM ET INQUISITIONUM IN PRIMOS SEX MENSES DESTINATARUM.

Historia Ventorum.

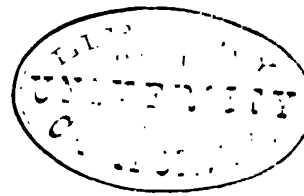
Historia Densi et Rari, necnon Coitionis et Expansionis Materiæ per spatia.

Historia Gravis et Levis.

Historia Sympathiæ et Antipathiæ Rerum.

Historia Sulphuris, Mercurii, et Salis.

Historia Vitæ et Mortis.



HISTORIA NATURALIS ET EXPERIMENTALIS AD CONDENDAM PHILOSOPHIAM:

SIVE

PHÆNOMENA UNIVERSI:

QUÆ EST INSTAURATIONIS MAGNÆ PARS TERTIA.

MONENDI utique sunt homines, et per fortunas suas rogandi atque obsecrandi, ut animos submittant et scientias in Mundo Majore quærant; quinetiam de philosophia vel cogitationem abjiciant, vel modicos saltem et tenues fructus ex illa sperent, usque dum Historia Naturalis et Experimentalis, diligens et probata, comparata sit et confecta. Quid enim sibi volunt ista cerebella hominum, et potentes nugæ? Fuerunt apud antiquos placita philosophorum valde numerosa; Pythagoræ, Philolai, Xenophanis, Heracliti, Empedoclis, Parmenidis, Anaxagoræ, Leucippi, Democriti, Platonis, Aristotelis, Theophrasti, Zenonis, aliorum. Hi omnes mundorum argumenta, tanquam fabularum, pro arbitrio confinxerunt, easque fabulas suas recitarunt, publicarunt; alias magis concinnas certe et probabiles, alias duriores. At nostris sæculis, propter instituta scholarum et collegiorum, cohibentur ingenia magis; neque propterea omnino cessatum est: Patricius, Telesius, Brunus, Severinus Danus, Gilbertus Anglus, Campanella[1], scenam tentarunt, et novas fabulas egerunt, nec plausu celebres nec argumento elegantes. Num hæc miramur? Quasi vero non possint infinita oriri hujusmodi placita et sectæ, omnibus

[1] This is, I believe, the only passage in which Bacon mentions Campanella.

sæculis? Neque enim est, aut erit, hujusce rei finis aliquis aut modus. Alius aliud arripit, aliis alia placent, nihil est luminis sicci et aperti; quisque ex phantasiæ suæ cellulis, tanquam *ex specu Platonis*, philosophatur; ingenia sublimiora, acutius, fœlicius; tardiora, minore successu, sed æqua pertinacia. Quin non ita pridem, ex quorundam virorum doctorum, et prout nunc sunt res excellentium, disciplina, scientiæ (credo propter varietatis et licentiæ tædia) intra certos et descriptos authores coërcentur, atque ita cohibitæ senioribus imponuntur, adolescentibus installantur; ut jam (quod cavillatus est Cicero in Cæsaris annum) *stella Lyræ ex edicto oriatur* [1], et authoritas pro veritate, non veritas pro authoritate sit. Quod genus institutionis et disciplinæ ad usum præsentem egregie valet; sed idem meliorum indicit exilium. Nimirum primorum parentum peccatum et luimus et imitamur. Illi Dei similes esse voluerunt, posteri eorum adhuc magis. Etenim mundos creamus, naturæ præimus et dominamur, omnia ita se habere volumus prout nostræ fatuitati consentaneum fore videtur, non prout Divinæ Sapientiæ, nec qualia inveniuntur in rebus ipsis; nec scio an res aut ingenia magis torqueamus; sed plane sigilla imaginis nostræ creaturis et operibus Dei imprimimus, non Creatoris sigilla cum cura inspicimus et agnoscimus. Itaque non immerito iterum de imperio in creaturas decidimus, et cum post lapsum hominis nihilominus dominatio nonnulla in creaturas reluctantes relicta fuerit, ut per veras et solidas artes subigi et flecti possint, id ipsum ex insolentia nostra, et quia Dei similes esse volumus et propriæ rationis dictamina sequi, maxima ex parte amittimus. Quamobrem, si qua est erga Creatorem humilitas, si qua operum ejus reverentia et magnificatio, si qua charitas in homines et erga necessitates et ærumnas humanas relevandas studium, si quis amor veritatis in naturalibus, et odium tenebrarum, et intellectus purificandi desiderium; orandi sunt homines iterum atque iterum, ut (missis paulisper aut saltem sepositis philosophiis istis volaticis et præposteris, quæ theses hypothesibus anteposuerunt, et experientiam captivam duxerunt, atque de operibus Dei triumpharunt,) summisse, et cum veneratione quadam, ad volumen creaturarum evolvendum accedant; atque in eo moram faciant, meditentur, et ab

[1] Plut. in Jul. Cæs. p. 735.

opinionibus abluti et mundi caste et integre versentur. Hic est ille sermo et lingua, qui exivit in omnes fines terræ[1], nec confusionem Babylonicam passus est; hunc perdiscant homines, et repuerascentes, atque iterum infantes facti, abecedaria ejusdem in manibus habere dignentur. In interpretatione autem ejus eruenda atque enucleanda nulli operæ parcant, sed strenue procedant, persistant, immoriantur. Cum igitur in Instauratione nostra historiam naturalem, qualis sit in ordine ad finem nostrum, in tertia operis parte collocaverimus; hanc rem prævertere et statim aggredi visum est. Etsi enim haud pauca, eaque ex præcipuis, supersint in Organo nostro absolvenda, tamen consilium est, universum opus Instaurationis potius promovere in multis, quam perficere in paucis; hoc perpetuo, maximo cum ardore (qualem Deus mentibus, ut plane confidimus, addere solet), appetentes, ut quod adhuc nunquam tentatum sit, id ne jam frustra tentetur. Simul subiit animum illa cogitatio: spargi proculdubio per Europam complura ingenia, capacia, libera, excelsa, subtilia, solida, constantia. Quid si quis, tali ingenio præditus, rationem et usum Organi nostri capiat, probet? Tamen non habet quid agat, nec quomodo se ad philosophiam comparet aut accingat. Si esset res quæ lectione librorum philosophicorum aut disputatione aut meditatione perfici posset, sufficeret fortasse ille, quisquis sit, et abunde illud præstaret. Quod si ad historiam naturalem et experimenta artium illum remittimus (id quod facimus), hæret, non est instituti ejus, non otii, non impensæ. Atqui non est postulandum nobis, ut quis vetera dimittat, antequam in possessionem meliorum inducatur. Postquam autem naturæ et artium historia fidelis et copiosa collecta et digesta fuerit, atque veluti ante oculos hominum posita et explicata, non tenuis est spes, ingenia de quibus diximus grandia (qualia et in antiquis philosophis viguerunt et adhuc non raro reperiuntur), cum tantæ antehac fuerint efficaciæ ut veluti ex *scalmo* aut *concha* (rara scilicet experientia et frivola) *naviculas* quasdam philosophiæ, admirabili structura quoad opificium, ædificaverint; multo magis postquam sylvam et materiem nacta sint, solidiores structuras excitatura; idque licet via veteri pergere malint, nec via nostri Organi (quæ, ut nobis videtur, aut unica

[1] Ps. lx. 4.—*J. S.*

est aut optima) uti. Itaque huc res redit, ut Organum nostrum, etiamsi fuerit absolutum, absque Historia Naturali non multum; Historia Naturalis absque Organo non parum, instaurationem scientiarum sit provectura. Quare omnino et ante omnia in hoc incumbere satius et consultius visum est. Deus universi Conditor, Conservator, Instaurator, hoc opus, et in ascensione ad gloriam suam, et in descensione ad bonum humanum, pro sua erga homines benevolentia et misericordia, protegat et regat, per Filium suum unicum, nobiscum Deum.

NORMA HISTORIÆ PRÆSENTIS.

QUAMVIS sub finem ejus partis Organi nostri quæ edita est præcepta de Historia Naturali et Experimentali conscripserimus[1]; visum est tamen hujus quam nunc aggredimur Historiæ normam et figuram et accuratius describere et succinctius. Titulis in Catalogo comprehensis qui pertinent ad Concreta, Titulos de Naturis Abstractis (quarum ibidem, ut Historiæ Reservatæ, mentionem fecimus) superaddimus. Hi sunt *Materiæ Schematismi* diversi, sive *Formæ Primæ Classis; Motus Simplices; Summæ Motuum; Mensuræ Motuum;* alia quædam De his Abecedarium Novum confecimus, et sub finem hujus voluminis collocavimus.

Titulos (cum ad omnes nullo modo sufficiamus) non ex ordine, sed ex delectu sumpsimus; quorum scilicet inquisitio, aut propter usum erat gravissima, aut propter copiam experimentorum maxime commoda, aut propter obscuritatem rei maxime difficilis et nobilis, aut propter discrepantiam titulorum inter se latissime patens ad exempla.

In titulis singulis, post Aditum quendam aut præfationem, statim *Topica Particularia,* sive articulos inquisitionis, proponimus, tum ad lumen inquisitionis præsentis tum ad provocationem futuræ. Domini enim quæstionum sumus, rerum non item. Neque tamen quæstionum ordinem in Historia ipsa præcise observamus, ne impedimento sit quod pro auxilio adhibetur.

Historia et Experimenta omnino primas partes tenent. Ea, si enumerationem et seriem rerum particularium exhibeant, in Tabulas conficiuntur; aliter seorsum excipiuntur.

Cum Historia et Experimenta sæpissime nos deserant, præ-

[1] Namely in the *Parasceve ad Historiam Naturalem et Experimentalem*, which was published with the first two books of the *Novum Organum*, of which it was to be the penultimate section. See *Nov. Org.* ii. 21.

sertim Lucifera illa et Instantiæ Crucis, per quas de veris rerum causis intellectui constare possit, *Mandata* damus de experimentis novis, quantum prospicere animo possumus, aptis ad id quod quæritur. Hæc mandata tanquam *Historia designata* sunt. Quid enim aliud nobis, primo viam ingredientibus, relinquitur?

Experimenti alicujus subtilioris *modum* quo usi sumus explicamus, ne error subsit; utque alios ad meliores et magis exactos modos excogitandos excitemus.

Monita et cautiones de rerum fallaciis, et qui in inquirendo et inveniendo possint occurrere erroribus et scrupulis, aspergimus; ut phantasmata omnia, quantum fieri potest, tanquam exorcismo fugemus.

Observationes nostras super Historiam et Experimenta subteximus, ut interpretatio naturæ magis sit in procinctu.

Commentationes et tanquam rudimenta quædam Interpretationis de Causis, parce, et magis suggerendo quid esse possit quam definiendo quid sit, interponimus.

Canones, sed tamen *mobiles*, sive axiomata inchoata, quæ nobis inquirentibus, non pronunciantibus, se offerunt, præscribimus et constituimus. Utiles enim sunt, si non prorsus veri.

Utilitatis humanæ nunquam obliti (licet lux ipsa dignior sit iis quæ a luce monstrantur), *Vellicationes de Practica* attentioni et memoriæ hominum subjicimus; cum nobis constet talem et tam infœlicem esse hominum stuporem, ut quandoque res ante pedes positas, nisi moniti, non videant, sed prætereant.

Opera et *res impossibiles*, aut saltem adhuc non inventas, quæ sub singulis titulis cadunt, proponimus; atque una ea quæ jam inventa sunt et in hominum potestate, atque *Impossibilibus* illis et non inventis sunt *Proxima* et maxime cognata, subjungimus; ut simul et industria humana excitetur atque animi addantur.

Patet ex antedictis, Historiam præsentem, non tantum Tertiæ Partis Instaurationis vices supplere, sed præparationem esse non contemnendam ad Quartam, propter titulos ex Abecedario, et Topica; et ad Sextam, propter Observationes Majores, Commentationes, et Canones.

HISTORIA VENTORUM.[1]

ADITUS, SIVE PRÆFATIO.

VENTI humanæ genti alas addiderunt. Eorum enim dono, feruntur homines et volant; non per aërem certe, sed per maria; atque ingens patet janua commercii, et fit mundus pervius. Terræ autem (quæ gentis humanæ sedes est et domicilium) scopæ sunt; eamque, atque simul aërem ipsum, everrunt et mundant. Attamen et mare infamant, alioqui tranquillum et innoxium; neque alias sine maleficio sunt. Motum, absque opera humana, cient magnum et vehementem; unde et ad navigandum et ad molendum veluti operarii conducti sunt; et ad multo plura adhiberi possunt, si humana non cesset diligentia. Natura ipsorum inter secreta et abdita reponi solet; nec mirum, cum nec aëris natura et potestas cognita quoquo modo sit; cui famulantur et parasitantur venti, ut (apud poëtas) Æolus Junoni. Primariæ creaturæ non sunt, nec ex operibus sex dierum; quemadmodum nec reliqua meteora quoad actum; sed post-nati, ex ordine creationis.

[1] The *Historia Vitæ et Mortis*, which was published in the following year, is described in the title-page as "Francisci B. de V. &c. Historia Vitæ et Mortis; sive *Titulus Secundus* in Historia Naturali et Experimentali ad condendam Philosophiam; quæ est Instaurationis magnæ pars tertia." To preserve symmetry, the *Historia Ventorum* should have been described here in a similar title-page, as *Titulus Primus* in Hist. Nat. et Exp. &c.; for the title at the beginning of the volume, the dedication, the preface commencing *Monendi utique sunt homines*, and the *Norma Historiæ præsentis*, were meant to apply to the whole series of histories which should have followed. But the fragmentary and imperfect character of the work is best represented by printing each piece in its original form.—*J. S.*

TOPICA PARTICULARIA:

SIVE

Articuli Inquisitionis de Ventis.

1. Describito ventos ex diligentia nautica, et imponito nomina ipsis, sive vetera sive nova, modo constantia.

Nomina Ventorum.

VENTI vel Generales sunt, vel Stati, vel Asseclæ, vel Liberi. Generales voco, qui semper flant; Statos, qui certis temporibus; Asseclas, qui frequentius; Liberos, qui indifferenter.

2. An sint venti aliqui Generales, atque ipsissimi motus aëris; et, si sint, in qua consecutione motus, et in quibus locis spirent?

Venti Generales.

3. Qui venti anniversarii sint, aut redeuntes per vices, et in quibus regionibus? An inveniatur ventus aliquis ita præcise Status, ut redeat regulariter ad dies certos et horas, instar æstus maris?

Venti Stati.

4. Qui venti sint Asseclæ, et familiares Regionum; qui Temporum, in iisdem regionibus; qui Verni; qui Æstivales; qui Autumnales; qui Brumales; qui Æquinoctiales; qui Solstitiales; qui Matutini, Meridiani, Vespertini, Nocturni?

Venti Asseclæ.

5. Quales sint venti Marini; quales qui spirant a Continente? Differentias autem Marinorum et Terrestrium diligenter excipito, tam eorum qui in terra et mari, quam eorum qui a terra et mari.

6. An non spirent venti ex omni Plaga Cœli?

Venti Liberi.

VENTI non multo plus Plagis Cœli, quam Qualitatibus, variant. Alii vehementes, alii lenes; alii constantes, alii mutabiles; alii calidi, alii frigidi; alii humectant magis et solvunt, alii desiccant et constipant; alii congregant nubes et sunt pluviosi vel etiam procellosi, alii dissipant et sunt sereni.

7. Inquirito et narrato, qui sint venti uniuscujusque speciei ex prædictis, et quomodo varient secundum regiones et loca?

Qualitates ventorum diversæ.

ORIGINES LOCALES ventorum triplices; aut dejiciuntur ex alto; aut emanant a terra; aut confiantur in ipso corpore aëris.

8. Secundum has tres Origines de ventis inquirito. Qui scilicet ex ipsis dejiciantur de Media (quam ve-

Origines locales ventorum.

cant) Regione Aëris; qui vero expirent e Cavis Terræ, sive illi erumpant confertim, sive effluent insensibiliter et sparsim, et postea glomerent ut rivuli in fluvium; qui denique generentur passim ex tumoribus sive expansionibus aëris proximi?

NEQUE GENERATIONES ventorum Originales tantum; sunt et Accidentales, ex compressionibus aëris scilicet, et percussionibus et repercussionibus ejus.

Generationes Accidentales ventorum.

9. De hujusmodi ventorum Generationibus Accidentalibus inquirito. Generationes ventorum proprie non sunt; etenim augent et fortificant ventos potius, quam producunt et excitant.

DE COMMUNITATE ventorum hactenus. Reperiuntur autem venti rari et prodigiosi, quales sunt Præster, Turbo, Ecnephias.[1] Hi super terram. At sunt et subterranei, quorum alii sunt vaporosi et mercuriales: ii percipiuntur in mineris; alii sulphurei: illi emittuntur, nacti exitum in terræ motibus, aut etiam effervescunt ex montibus ardentibus.

Venti extraordinarii et flatus repentini.

10. De hujusmodi ventis Raris et Prodigiosis, atque adeo de omnibus ventorum Miraculis inquirito.

A SPECIEBUS ventorum transeat inquisitio ad Confacientia ad ventos (ita enim loqui volumus, quia vocabulum Efficientis plus significat, vocabulum Concomitantis minus, quam intelligimus), atque ad ea quæ ventos putantur excitare aut sedare.

Confacientia ad ventos, et excitantia et sedantia ipsos.

11. Circa Astrologica de ventis inquirito parce, nec de accuratis Schematibus Cœli curato; tantummodo observationes manifestiores de ventis ingruentibus circa exortus aliquorum astrorum, aut circa eclipses luminarium, aut conjunctiones planetarum, ne negligito; nec minus quatenus pendent ex viis solis aut lunæ.

12. Quid confaciant Meteora diversorum generum ad ventos? Quid Terræ Motus, quid Imbres, quid Concursus ventorum ad invicem? Concatenata enim sunt ista, et alterum alterum trahit.

13. Quid confaciant ad ventos, Vaporum et Exhalationum diversitas? Et quæ ex ipsis sint magis ge-

[1] See Pliny, ii. 49. and 50.

nerativa ventorum, et quatenus natura ventorum sequatur hujusmodi Materias suas?

14. Quid confaciant ea quæ hic in Terra sunt aut fiunt, ad ventos; quid montes, et solutiones nivium in ipsis; quid moles glaciales, quæ in mari innatant et deferuntur alicubi; quid differentiæ soli aut terræ (modo hoc fuerit per tractus majores) veluti paludes, arenæ, sylvæ, campestria; quid ea quæ hic apud homines aguntur, veluti incensiones ericæ et similium, ad culturam agrorum; incensiones segetum aut villarum in bellis; desiccationes paludum; displosiones continuæ bombardarum; sonitus campanarum simul in magnis urbibus; et similia? Festucæ certe sunt res nostræ, sed tamen aliquid possunt.

15. De omnimodis Excitationibus aut Sedationibus ventorum inquirito, sed parce de fabulosis aut superstitiosis.

A CONFACIENTIBUS ad ventos transeat inquisitio ad inquirendos Limites ventorum; de Altitudine, Extensione, Duratione eorum.

Limites ventorum.

16. Inquirito diligenter de Altitudine sive Elevatione ventorum; atque si sint fastigia montium ad quæ venti non aspirent; aut si conspiciantur nubes quandoque stare et non movere, flantibus eodem tempore ventis fortiter hic in terra.

17. Inquirito diligenter de Spatiis quæ venti deprehensi sunt simul occupare, et ad quos terminos? Exempli gratia, si Auster flaverit tali loco, an constet quod eodem tempore Aquilo flaverit ab illinc milliaribus decem? Contra, in quantas angustias venti redigi possint, ita ut fluant venti (id quod fieri videtur in Turbinibus nonnullis) tanquam per canales.

18. Inquirito ad quod tempus, vel maximum vel medium vel minimum, continuari soleant venti, et deinde flaccescere et tanquam expirare; qualis etiam esse soleat ortus et inceptio ventorum, qualis languor et cessatio; subito, gradatim, quoquo modo?

A LIMITIBUS ventorum transeat inquisitio ad Successiones ventorum, vel inter se vel respectu pluviæ et imbrium. Cum enim choreas ducant, ordinem saltationis nosse jucundum fuerit.

19. An sit aliqua regula, aut observatio paulo certior, de Successionibus ventorum ad invicem, sive ea sit in ordine ad motum solis, sive alias; et si sit, qualis sit illa? Successiones ventorum.

20. Circa Successionem et Alternationem Ventorum et Pluviæ inquirito; cum illud familiare et frequens sit, ut Pluvia sedet Ventos, Venti compescant et dissipent Pluviam.

21. An post certam Periodum annorum redintegretur Successio ventorum; et si ita sit, quæ sit ea periodus?

A SUCCESSIONIBUS ventorum transeat inquisitio ad Motus ipsorum. Motus ventorum septem inquisitionibus absolvuntur; quorum tres superioribus articulis continentur, quatuor adhuc manent intactæ. Nam de motu ventorum dispertito per plagas cœli inquisitum est. Etiam de motu trium linearum, sursum, deorsum, lateraliter. Etiam de accidentali motu compressionum. Restant motus quartus Progressivus; quintus Undulationis; sextus Conflictus; septimus in Organis et Machinis Humanis.

22. Cum Progressus sit semper a termino, de loco primi ortus, et tanquam fontibus alicujus venti, quantum fieri potest, diligenter inquirito. Siquidem videntur venti Famæ similes. Nam licet tumultuentur et percurrant, tamen *caput inter nubila condunt.* Item de Progressu ipso. Exempli gratia, si Boreas vehemens, qui flaverit Eboraci ad talem diem aut horam, flaverit Londini biduo post? Motus diversi ventorum.

23. De Undulatione ventorum inquisitionem ne omittito. Undulationem vocamus eum motum quo ventus ad parva intervalla intenditur et remittitur, tanquam undæ aquarum; quarum vices optime percipiuntur ex auditu in ædibus. Eo autem magis notato diligenter differentias Undulationis, sive Sulcationis inter aërem et aquam; quia in aëre et ventis deest motus gravitatis, qui pars magna est Undulationis in aquis.

24. De Conflictu et concursu ventorum flantium ad idem tempus diligenter inquirito. Primo, utrum flent simul plures venti Originales, non dicimus reverberantes? Et, si hcc ita sit, quales Euripos in

motu, quales rursus Condensationes et Alterationes in corpore aëris gignant?

25. An venti alii eodem tempore flent superius, alii hic apud nos in imo? Quandoquidem observatum est a nonnullis, interdum nubes ferri in contrarium versionis pinnaculi; etiam nubes ferri forti aura, cum hic apud nos fuerit summa tranquillitas.

26. Fiat descriptio diligens admodum et particularis Motus ventorum in impulsu Navium per vela.

27. Fiat descriptio motus ventorum in velis Molendorum ad ventum; in volatu accipitrum et avium, etiam in vulgaribus et ludicris, veluti signorum explicatorum, draconum volantium, duellorum ad ventum, &c.

A MOTIBUS ventorum transeat inquisitio ad Vim et Potestates ipsorum.

Potestates ventorum.

28. Quid possint et agant venti circa Currentes et æstus aquarum, et circa detentiones, immissiones, et inundationes ipsarum?

29. Quid circa Plantas et Insecta, inducendo locustas, erucas, malos rores?

30. Quid circa Purgationem et Infectionem aëris, et circa Pestilentias, morbos, et affectus animalium?

31. Quid circa Delationem Specierum (quas vocant) Spiritalium, ut Sonorum, Radiorum, et similium?

A POTESTATIBUS ventorum transeat inquisitio ad Prognostica ventorum, non solum propter usum prædictionum, sed quia manu ducunt ad causas; prognostica enim aut Præparationes rerum monstrant antequam perducantur ad actum, aut Inchoationes antequam perducantur ad sensum.

Prognostica ventorum.

32. Colligantur, cum diligentia bona, Prognostica ventorum omnigena (præter astrologica, de quibus superius diximus quatenus sint inquirenda), sive petantur ex Meteoricis, sive ex Aquis, sive ex Instinctu Animalium, aut quovis alio modo.

POSTREMO inquisitionem claudito, inquirendo de IMITAMENTIS ventorum, sive in naturalibus sive in artificialibus.

Imitamenta ventorum.

33. Inquirito de Imitamentis ventorum in Naturalibus; qualia sunt Flatus in Corporibus Animalium, flatus in Receptaculis Distillationum, &c.

Inquirito de auris factis et Ventis Artificialibus, ut follibus, refrigeratoriis in cœnaculis, &c.

Articuli tales sint. Neque nobis dubium est, quin ad nonnullos horum responderi non possit, secundum copiam experientiæ quam habemus. Verum quemadmodum in causis civilibus quid causa postulet ut interrogetur noverit jurisconsultus bonus, quid testes respondere possint non norit; idem nobis circa Historiam Naturæ accidit. Posteri cætera viderint.

HISTORIA.

Nomina Ventorum.

Ad Art. 1. Nomina ventis, potius ex ordine et gradibus numerata, quam ex antiquitate propria, imponimus; hoc perspicuitatis et memoriæ gratia. Sed vocabula antiqua adjicimus quoque, propter suffragia authorum veterum, ex quibus cum haud pauca (licet anxio quodam judicio) exceperimus, non agnoscentur fere illa, nisi sub nominibus quibus illi usi sunt. Partitio autem generalis ea esto; ut sint venti Cardinales, qui spirant a cardinibus mundi; Semicardinales, qui in dimidiis: Mediani, qui in intermediis. Etiam ex intermediis Mediani Majores vocentur, qui in quadris; Minores reliqui. Particularis autem divisio ea est quæ sequitur.

Cardin.	Boreas. Bor. 1. ad Eurum.	Eurus, sive Subsolanus. Eurus 1. ad Austrum.	Auster, sive Notus. Auster 1. ad Zephyrum.	Zephyrus, sive Favonius. Zephyrus 1. ad Boream.
Med. Maj.	Bor. 2. ad Eur. sive Aquilo. Bor. 3. ad Eur. sive Meses.	Eur. 2. ad Austr. sive Vulturnus. Eurus 3. ad Austrum.	Aust. 2. ad Zeph. sive Libonotus. Auster 3. ad Zephyrum.	Zeph. 2. ad Bor. sive Corus. Zephyrus 3. ad Boream.
Semicar.	Euro-Boreas. Eurus 1. a Borea.	Euro-Auster. Auster 1. ab Euro.	Zephyro-Aust. sive Lybs. Zephyrus 1. ab Austro.	Zephyro-Boreas. Bor. 1. a Zeph. sive Thrascias.
Med. Maj.	Eurus 2. a Bor. sive Cæcias. Eurus 3. a Borea.	Aust. 2. ab Euro, sive Phœnicias. Auster 3. ab Euro.	Zeph. 2. ab Aust. sive Africus. Zephyrus 3. ab Austro.	Bor. 2. a Zeph. sive Circias. Boreas 3. a Zephyro.

Sunt et alia ventorum nomina Apeliotes, Argestes, Olympias, Scyron, Hellespontius, Iapyx.[1] Ea nil moramur. Satis sit nomina ventorum ex ordine et distributione plagarum cœli fixa imposuisse. In interpretatione authorum non multum ponimus, cum in ipsis authoribus parum sit.

Venti Liberi.

Ad Art. 6. 1. Non est plaga cœli, unde ventus non spiret. Quin si plagas cœli in tot partes dividas quot sunt gradus in Horizonte, invenias ventos aliquando alicubi a singulis flantes.

2. Sunt regiones totæ in quibus non pluit, aut raro admodum. At non sunt regiones ubi non flent venti, et sæpius.

Venti Generales.

Ad Art. 2. De ventis Generalibus phænomena rara. Nil mirum, cum intra Tropicos præcipue perspiciantur, loca damnata apud antiquos.

1. Constat navigantibus inter tropicos, libero æquore, flare ventum constantem et jugem (*Brizam* vocant nautæ) ab oriente in occidentem. Is non ita segnis est, quin partim flatu proprio, partim regendo currentem maris, id efficiat, ut nequeant navigantes versus Peruviam eadem redire qua proficiscuntur via.[2]

2. In nostris maribus Europæ, percipitur cœlo sereno et sudo, et cessantibus ventis particularibus, aura quædam lenis ab oriente, solisequa.

3. Recipit observatio vulgaris, nubes sublimiores ferri plerumque ab oriente in occidentem; idque cum, iisdem temporibus, circa terram aut tranquillitas sit aut ventus diversus. Id si non semper faciant, poterit in causa esse, quod venti particulares quandoque flant in sublimi, qui ventum istum generalem obruunt.

Monitum. Si quis sit talis Ventus Generalis ex ordine motus cœli, is non adeo firmus est, quin Ventis Particularibus cedat. Manifestior autem est intra Tropicos, propter circulos quos

[1] All these names of winds may be found in Pliny, ii. 44. except Iapyx; for which see Seneca, *Nat. Quæst.* v. 17. The identification of Eurus with Subsolanus is sanctioned by Aulus Gellius, ii. 22. Generally speaking, Eurus is made to correspond with Vulturnus. Gilbert, in his *Physiologia*, iv. 4, proposes to give a table of winds which apparently would have been similar to Bacon's; but the MS. is imperfect, and Gruter supplies the lacuna by a transcript of the latter.

See, as to the identification of Eurus with Subsolanus, Smith, *Voyage and Shipwreck of St. Paul*, p. 59., and the appendix.

[2] In Acosta's History of the Indies (I use Regnault's French translation, 1600), the trade wind is called brise, which corresponds to Bacon's *briza*. Acosta mentions the difference between the course followed in going to Peru and in returning from it. See *Hist. des Indes*, iii. 4.

conficit majores; etiam in sublimi, propter eandem causam et propter cursum liberum. Quamobrem, si hic extra Tropicos et juxta terram (ubi mollis admodum et segnis est) eum deprehendere voles, fiat experimentum in aëre libero, et in summa tranquillitate, et in locis altis, et in corpore valde mobili, et tempore pomeridiano, quia per id tempus ventus orientalis particularis parcius flat.

Mandatum. Fiat diligens observatio circa pinnacula, et ejusmodi flabella, in fastigiis turrium et templorum, annon in maximis tranquillitatibus stent perpetuo versus occidentem?

Phænomenon obliquum.

4. Constat Eurum, in Europa nostra, esse ventum desiccantem et acrem, Zephyrum contra humectantem et almum. Annon hoc fit, quia (posito quod aër moveat ab oriente in occidentem) necesse est ut Eurus, qui moveat in eadem consecutione, aërem dissipet et attenuet; unde fit aër mordax et siccus; Zephyrus autem, qui in contraria, aërem in se vertat et condenset; unde fit obtusior, et demum humidus.

Phænomenon obliquum.

5. Consulito inquisitionem de motu et fluxu aquarum, utrum illæ moveant ab oriente ad occidentem. Nam si extrema hoc motu gaudeant, cœlum et aquæ, parum abest quin aër, qui intermedius est, ex eodem participet.

Monitum. Phænomena duo, proxime posita, *obliqua* appellamus, quia rem designatam non recta monstrant, sed per consequens; id quod (cum deest copia phænomenorum *rectorum*) etiam avide recipimus.

Mandatum. Quod *Briza* illa inter Tropicos luculenter spiret, res certa, causa ambigua. Possit ea esse, quia aër, more cœli, movetur; sed extra Tropicos, quasi imperceptibiliter, propter circulos minores; intra, manifesto, propter circulos majores quos conficit. Possit alia esse, quia calor omnem aërem dilatat, nec se priore loco contineri patitur. Ex dilatatione autem aëris necessario fit impulsio aëris contigui, quæ *brizam* istam pariat prout progreditur sol. Sed illa intra Tropicos, ubi sol est ardentior, insignior est; extra, fere latet. Videtur esse Instantia Crucis, ad ambiguitatem istam tollendam, si inquiratur, utrum briza noctu flet, an non? Rotatio enim aëris etiam noctu manet, at calor solis non item.

6. At certum est illam noctu non flare, sed mane, aut etiam

aurora adulta. Nihilominus non determinat illa Instantia quæstionem. Nam condensatio aëris nocturna, præsertim in illis regionibus ubi nox et dies non magis pares sunt spatiis quam differentes calore et frigore, possit motum illum naturalem aëris (qui lenis est) hebetare et confundere.

7. Si aër participet ex motu cœli, sequitur non tantum quod Eurus cum motu aëris concurrat, Zephyrus concertet; verum etiam quod Boreas tanquam ab alto spiret, Auster tanquam ab imo, in hemisphærio nostro, ubi Polus Antarcticus sub terra est, Arcticus elevatur; idque etiam ab antiquis notatum est, sed titubanter et obscure[1]; optime autem convenit cum experientia moderna, quia *briza* (quæ possit esse motus aëris) non est Eurus integer, sed Euro-aquilo.[2]

Venti Stati.

Ad Art. 8. *Connexio.*

Ut in inquisitione de ventis Generalibus homines *scototomiam* passi sunt, ita in illa de ventis Statis *vertiginem:* de illa silent, de hac sursum et deorsum sermones faciunt inconditos. Ignoscendum hoc magis, quod varia res est: quia Stati Venti cum locis permutantur, ut non iidem in Ægypto, Græcia, Italia spirent.

1. Esse alicubi Statos Ventos, etiam nomen impositum declarat; ut et nomen alterum Etesiarum, quod Anniversarios sonat.

2. Apud antiquos inter causas inundationis Nili ascripta est, quod eo anni tempore Venti Etesiæ (Aquilones scilicet) flarent, qui cursum fluvii in mare inhibebant et retrorsum volvebant.[3]

3. Inveniuntur in mari currentes, qui nec naturali motui oceani, nec decursui ex locis magis elevatis, nec angustiis ex

[1] Bacon means that in our hemisphere there is a constant cause tending to make north winds more common than south, as well as one which tends to make east winds more common than west. These causes combined make the trade wind blow from the north-east. That north winds predominate over south, arises in his opinion from this: that the north wind blows straight down from the North Pole; whereas wind from the South Pole, which is below our horizon, can only reach us by a devious course. The confusion of thought in this passage is the same as that which has given rise to the names vent d'amont and vent d'aval, for the north and south winds respectively. See Ideler, *Meteorol. Græc. et Lat.* p. 111., who refers, among other passages, to Pliny, ii. 48., in illustration of the notion of the north wind's coming from above.

[2] Euro-Aquilo is the reading of the Vulgate, where the received Greek text of the Acts has Euroclydon. It would be curious to know whether Bacon took it from the Vulgate or only formed it, as previously he had formed to denote the same wind the word Euro-boreas. There can be little doubt that the reading proposed by Bentley, εὐρακύλων, is correct. Acts, xxvii. 14.

[3] Herod. ii. 20. and Plin. v. 10.

litoribus adversis aut promontoriis excurrentibus attribui possint; sed plane reguntur a Ventis Statis.

4. Columbum qui nolunt a relatione naucleri Hispani, et levius putant ab obscuris antiquitatis vestigiis et auris, tam certam et fixam de Indiis Occidentalibus opinionem concepisse, huc se convertunt, quod a Statis Ventis ad litora Lusitaniæ conjecerit Continentem esse a parte occidentis[1]: res dubia, nec admodum probabilis, cum ventorum itinerarium ad tam longos tractus vix attingat. Magnus interim honos huic inquisitioni, si uni axiomati aut observationi, ex iis quas multas complectitur, inventio Novi Orbis debeatur.

5. Ubicunque siti sunt montes alti et nivales, ab ea parte flant Venti Stati ad tempus quo nives solvuntur.

6. Arbitror et a paludibus magnis quæ aquis cooperiuntur hieme, spirare Ventos Statos, sub tempora quibus a calore solis siccari cœperint; sed de hoc mihi compertum non est.

7. Ubicunque generationes vaporum fiunt in abundantia, idque certis temporibus, ibi scias Ventos Statos iisdem temporibus orituros.

8. Si Venti Stati flent alicubi, nec causa eorum reperiatur in propinquo; scias Ventos hujusmodi Statos peregrinos esse, et a longe venire.

9. Notatum est, Ventos Statos noctu non flare, sed tertia ab ortu solis hora insurgere. Sunt certe hujusmodi venti veluti ex longo itinere defessi, ut condensationem aëris nocturnam vix perfringant, at post exortum solis excitati paulisper procedant.

[1] Bacon refers to a story first told by Oviedo, that a vessel going from Spain to England was driven out of its course so far as to reach the West Indies; that on their return home all the crew, which had been reduced to the pilot and three or four sailors, were sick, and shortly afterwards died; that the pilot died in the house of Columbus, and that from him Columbus obtained exclusive possession of the discovery, which had been accidentally made. Oviedo says that this story was commonly told, but that he would not vouch for its truth. Humboldt remarks that this story was not brought forward in the fiscal proceedings, and that Oviedo was the first to tell it (in 1535). He adds that it was not till 1609 that Garcilasso de la Vega ventured to give a name—Alonzo Sanchez de Hecelva—to the pilot, and a date—1484—to the story. The authority for Bacon's statement is Peter Martyr Anghiera, who says that Columbus had often remarked from the shore of Portugal, in certain times of the year, there blew from the west a steady wind which lasted for many days, and considered that it could only come from the earth which generated it on the other side of the sea. It is remarkable that neither Ferdinand Columbus nor Herrera, who both speak of indications derived from wood and other things picked up off the Azores, mentions this indication derived from the wind; nor does Humboldt, in his *Examen Critique de l'Histoire de Géographie*. It is manifestly derived from the Aristotelian doctrine of the origin of winds, and not, as Bacon supposed, from the greater steadiness of land winds compared with those which blow from the sea. See Ramusio's *Collection of Voyages*, 1606, vol. iii. p. 1. a. and p. 64. c.; and Humboldt, l. c. vol. ii. p. 155.

10. Omnes Stati Venti (præterquam ex locis propinquis) imbecilli sunt, et ventis subitis se submittunt.

11. Sunt complures Venti Stati, quos nos non percipimus aut observamus, propter infirmitatem ipsorum, unde a ventis liberis obruuntur. Ideo vix notantur hieme, cum venti liberi vagantur magis; sed potius versus æstatem, cum venti illi erratici magis deficiant.

12. In partibus Europæ ex Ventis Statis hi potissimi sunt. Aquilones, a solstitio; suntque exortus caniculæ tum prodromi tum sequaces; Zephyri, ab æquinoctio autumnali; Euri a verno.[1] Nam de brumali solstitio minus curandum propter hiemis varietates.

13. Venti Ornithii, sive Aviarii, qui nomen traxerunt quod aves a regionibus gelidis transmarinis regionibus apricis immittant[2], nihil pertinent ad Ventos Statos; quia illi tempore sæpius fallunt; aves autem eorum commoditatem, sive citius sive tardius flent, expectant; etiam non raro, postquam flare paululum inceperint et se subinde verterint, destituuntur aves et merguntur in pelago, aliquando in naves decidunt.

14. Præcisus reditus ventorum ad diem et horam, instar æstus maris, non invenitur. Designant quandoque authores nonnulli diem; sed potius ex conjectura, quam ex observatione constante.

Venti Asseclæ.

Ad Art. 4. et 5. *Connexio.* Ventorum Asseclarum vocabulum nostrum est; quod imponere visum est, ne aut pereat observatio circa ipsos aut confundatur. Sensus talis est. Divide, si placet, annum in tres, quatuor, quinque partes, in aliqua regione. Quod si ventus aliquis ibi flet duas, tres, quatuor portiones ex ipsis, ventus contrarius unam; illum ventum, qui frequentius flat, ejus regionis *Asseclam* nominamus. Sic de temporibus.

1. Auster et Boreas Asseclæ mundi sunt; frequentius enim per universum spirant illi, cum suis sectionibus, quam Eurus et Zephyrus cum suis.

2. Omnes venti Liberi (non Stati) magis asseclæ hiemis sunt, quam æstatis, maxime autem autumni et veris.

[1] Compare Pliny, ii. 47.

[2] The Ornithias of Pliny seems to be a westerly wind, so called because it blows for nine days after the swallows come. See Pliny, ii. 47. and 48.

3. Omnes venti liberi potius assecłæ sunt regionum extra tropicos, atque etiam circulos polares, quam intra; in regionibus enim torridis et conglaciatis plerunque parcius spirant, in mediis frequentius.

4. Etiam omnes venti liberi, præsertim fortiores ex ipsis, flant sæpius et intensius mane et vesperi, quam meridie et noctu.

5. Venti liberi in regionibus fistulosis et cavernosis frequentius spirant, quam in firmis et solidis.

Mandatum. Cessavit fere humana diligentia in observatione Ventorum Asseclarum in regionibus particularibus, quod tamen fieri debuit, et ad multa utilis foret. Memini me a mercatore quodam, prudenti viro, qui ad Terram Piscationis[1] coloniam duxerat ibique hiemarat, causam quæsivisse cur regio illa tam impense frigida haberetur, cum clima satis benignum esset. Respondit, rem esse fama aliquanto minorem, causam autem duplicem. Unam, quod moles glaciales a currenti maris Scythici juxta ea litora deveherentur. Alteram (quam longe potiorem duxit), quod longe pluribus anni partibus spiraret apud eos Zephyrus, quam Eurus; quod etiam facit apud nos (inquit); sed apud illos a continenti et gelidus, apud nos a mari et tepidus. Quod si (addidit) tam frequenter et diu spiraret in Anglia Eurus, quam apud eos Zephyrus, longe forent intensiora frigora apud nos, et paria illis quæ ibi fiunt.

6. Zephyri sunt asseclæ horarum pomeridianarum. Declinante enim sole frequentius spirant venti ab occidente, ab oriente rarius.

7. Auster noctis assecla est; nam noctu et sæpius oritur et flat vehementius. Boreas autem interdiu.

8. Asseclarum vero maris et continentis, multæ et magnæ sunt differentiæ. Ea præcipue, quæ Columbo ansam præbuit inveniendi Novi Orbis: quod venti marini Stati non sunt, terrestres autem maxime.[2] Cum enim abundet vaporibus mare, qui ubique fere indifferenter adsunt, ubique etiam generantur venti, et magna inconstantia huc illuc feruntur, cum certas origines et fontes non habeant. At terra ad materiam ventorum valde inæqualiter se habet; cum alia loca ad ventos pariendos et augendos magis efficacia sint; alia magis destituta.

[1] The terra piscationis is Newfoundland.

[2] See the note at p. 29.

Itaque flant fere a parte fomitum suorum, et inde directionem sortiuntur.

9. Non satis constat sibi Acosta. Ait ad Peruviam et maritima Maris Australis fere per totum annum spirare Austros. Idem alibi ait ad eas oras spirare potissimum ventos marinos. At Auster illis terrestris est, ut et Boreas et Eurus, tantumque Zephyrus est illis marinus.[1] Sumendum quod certius ponit, hoc est, Austrum esse ventum asseclam et familiarem earum regionum; nisi forte ex nomine Maris Australis vel phantasiam vel modum loquendi corrupit, intelligens Zephyrum per Austrum, quod a Mari Australi spiret. At mare, quod vocant, Australe, proprie Australe non est, sed tanquam oceanus secundus occidentalis; quando simili cum Atlantico situ exporrigatur.

10. Marini venti sunt proculdubio terrestribus humidiores, sed tamen puriores, quique facilius et æqualius cum aëre puro incorporentur. Terrestres enim male coagmentati et fumei. Neque opponat quispiam, eos debere esse, propter salsuginem maris, crassiores. Natura enim terrestris salis non surgit in vaporibus.

11. Tepidi vel gelidi sunt venti marini, pro ratione qualitatum duarum prædictarum, humiditatis et puritatis. Humiditate enim frigora mitigant (siccitas siquidem utrumque, et calorem et frigus, intendit); at puritate refrigerant. Itaque extra tropicos, tepidi; intra, gelidi.

12. Arbitror ubique ventos marinos asseclas esse regionum (præsertim maritimarum) singularum; frequentius scilicet spirare ventos a parte ubi collocatur mare, propter copiam longe uberiorem materiæ ad ventos in mari, quam in terra; nisi forte sit aliquis ventus Status, spirans a terra, ex causa peculiari. Nemo autem confundat ventos Statos cum ventis Asseclis, cum asseclæ semper frequentiores sint, stati sæpius rariores. Id tamen utrisque commune est, quod venti spirent a parte fomitum suorum.

13. Vehementiores plerunque sunt venti marini, quam terrestres; ita tamen, ut, cum cessent, major sit malacia in medio mari, quam ad litora; adeo ut nautæ quandoque ament potius litorum obliquitates premere, quam urgere altum; ad evitandas malacias.

[1] Acosta, Hist. des Indes, iii. 20. and ii. 13. There is no discrepancy between the two statements, as the coast of Peru runs from north-west to south-east.

14. Spirant a mari ad litora venti Tropæi sive versarii, qui scilicet postquam paulisper progressi sunt, subito vertuntur. Omnino est quædam refractio inter auras maris et auras terræ, et inæqualitas. Omnis autem inæqualitas aëris est inchoatio quædam venti. Maxime autem fiunt Tropæi et Euripi ventorum ubi mare sinuat.

15. Spirant quædam auræ plerunque circa omnes aquas majores; potissimum autem sentiuntur mane; at magis circa fluvios quam in mari, propter differentiam auræ terræ et auræ aquæ.

16. In locis proximis juxta mare, flectunt fere se arbores et incurvant, quasi aversantes auras maris. Neque tamen malicia est; sed venti maritimi, ob humiditatem et densitatem, sunt tanquam ponderosiores.

Qualitates et Potestates Ventorum.

Ad Art. 7. 27, 28, 29, 30, 31. *Connexio.*

Circa Qualitates et Potestates Ventorum observatum est ab hominibus non diligenter et varie. Nos certiora excerpimus; reliqua, ut levia, ipsis ventis permittemus.

1. Auster pluviosus, Boreas serenus apud nos sunt. Alter nubes congregat et fovet, alter dissipat et discutit. Itaque poëtæ, cum narrant de Diluvio, fingunt eo tempore Boream in carcere conclusum; Austrum cum amplissimis mandatis emissum.

2. Zephyrus apud nos pro Aureæ Ætatis vento habitus est, qui comes esset perpetui veris, et mulceret flores.

3. Paracelsi schola, cum tribus suis principiis etiam in Templo Junonis (aëre scilicet) locum quærerent, tres collocarunt; Euro locum non repererunt.

> "Tincturis liquidum qui *mercurialibus* Austrum,
> Divitis et Zephyri rorantes *sulphure* venas,
> Et Boream tristi rigidum *sale*." [1]

4. At nobis in Britannia Eurus pro malefico habetur, ut in proverbio sit, Eurum neque homini neque bestiæ propitium esse.

5. Auster a præsentia solis, Boreas ab absentia spirat, in hemisphærio nostro. Eurus in consecutione motus aëris, Ze-

[1] Johannes Pratensis. These lines occur in a complimentary address to Severinus, appended to his *Idea Medicinæ Philosophicæ*.

phyrus in contrarium, ubique. Zephyrus a mari, Eurus a continente; plerunque in Europa et Asia occidentali. Hæ sunt differentiæ ventorum maxime radicales, unde plurimæ ex qualitatibus et potestatibus ventorum revera pendent.

6. Auster minus anniversarius est et status quam Boreas, sed magis vagus et liber[1]; et quando est status, tam lenis est ut vix percipiatur.

7. Auster magis humilis est et lateralis, Boreas celsior et spirans ex alto; neque hoc de elevatione et depressione polari dicimus, de qua supra, sed quod origines suas habeat plerunque magis in vicino Auster, magis in sublimi Boreas.

8. Auster nobis pluviosus (ut jam dictum est) Africæ vero serenus, sed magnos immittens fervores, non frigidus (ut alii dixerunt).[2] Est tamen Africæ satis salubris; at nobis, si flaverit paulo diutius in sudo absque pluvia Auster, valde pestilens est.

9. Auster et Zephyrus non generant vapores, sed spirant a partibus ubi maxima est copia ipsorum, propter auctum calorem solis, qui vapores elicit, ideoque sunt pluviosi. Quod si spiraverint a locis siccioribus et jejunis a vaporibus, sunt sereni; sed tamen aliquando puri, aliquando æstuosi.

10. Videntur hic apud nos Auster et Zephyrus fœderati, suntque tepidi et humidi; at ex altera parte affines sunt Boreas et Eurus, suntque frigidi et sicci.

11. Auster et Boreas (quod et antea attigimus) frequentius spirant quam Eurus et Zephyrus; quia magna est inæqualitas vaporum ex illis partibus, propter absentiam et præsentiam solis; at orienti et occidenti sol tanquam adiaphorus est.[3]

12. Auster saluberrimus marinus, a continente magis morbidus; contra Boreas a mari suspectus, a terra sanus; etiam frugibus et stirpibus Auster marinus valde benignus, fugans rubigines et alias pernicies.[4]

13. Auster lenior non admodum cogit nubes, sed sæpe serenus est, præsertim si sit brevior; sed flans commotius aut diutius, facit cœlum nubilum et inducit pluviam; sed potius cum desinat aut flaccescere incipiat, quam a principio aut in ipso vigore.[5]

[1] Aristotle, Problem § De Ventis, 2.
[2] Namely Aristotle, ubi sup. 51.; and see the next problem for the assertion that a dry south wind is unwholesome.
[3] Cf. Arist. ubi sup. 37.
[4] Id. ib. 19.
[5] Id. ib. 21, 22. and 40.

14. Cum Auster aut oritur aut desistit, fiunt fere mutationes tempestatum a sereno ad nubilum, aut a calido ad frigidum, et e contra; Boreas sæpe et oritur et desinit, priore tempestate manente et continuata.

15. Post pruinas, atque etiam nives paulo diuturniores, non alius fere ventus quam Auster spirat [1], tanquam facta concoctione frigorum, quæ tum demum solvuntur, neque propterea semper sequitur pluvia, sed fit hoc etiam in regelationibus serenis.

16. Auster et frequentius oritur et fortius spirat noctu quam interdiu, præsertim noctibus hibernis. At Boreas, si noctu oriatur (quod contra suam consuetudinem est), non ultra triduum fere durat.[2]

17. Austro flante majores volvuntur fluctus quam Borea, etiam quando pari aut minore impetu spirat.

18. Spirante Austro fit mare cœruleum et magis lucidum; Borea contra atrius et obscurius.[3]

19. Cum aër subito fit tepidior, denotat interdum pluviam; rursus alias, cum aura subito fit gelidior, pluviam præmonstrat. Sequitur vero hoc naturam ventorum; nam si flante Austro aut Euro intepescit aër, pluvia in propinquo est; itidemque cum flante septentrione aut Zephyro refrigescit.

20. Auster flat plerunque integer et solitarius. At Borea, et præcipue Cæcia et Coro flantibus, sæpe contrarii et alii diversi venti simul spirant; unde refringuntur et turbantur.

21. Boreas sementi faciendæ, Auster insitionibus et inoculationibus, cavendus.[4]

22. A parte Austri folia ex arboribus citius decidunt; at palmites vitium ab ea parte erumpunt, et eo fere spectant.[5]

23. In latis pascuis, videndum est pastoribus (ut ait Plinius) ut greges ovium ad septentrionale latus adducant, ut contra Austrum pascant. Nam si contra Boream, claudicant et lippiunt et alvo moventur [6]: quinetiam Boreas coitum illis debilitat, adeo ut si in hunc ventum spectantes coëant oves, fœmellæ ut plurimum gignantur. Sed in hoc Plinius (utpote transcriptor) sibi non constat.[7]

[1] Arist. ubi sup. 3. [2] Id. ib. 9. and 15. [3] Id. ib. 39.
[4] Pliny, xviii. c. 33. and 34. [5] Pliny, xviii. 33.
[6] "Clodunt ita lippiuntve ab afflatu et alvo citâ pereunt."—*Pliny*, ubi suprà. But Bacon either mistook clodunt for claudicant, or was ignorant of the meaning of the former word. ["Clodunt ita (*oculos*) lippiuntque ab afflatu." *Facciol.* in voc.—*J. S.*]
[7] Compare Pliny, viii. 72., with the passage just referred to. It may however be said that there is no absolute contradiction between the two passages.

24. Venti tribus temporibus frumento et segetibus nocent; in flore aperiente, et deflorescente, et sub maturitatem: tum enim exinaniunt aristas dejectis granis, at prioribus duobus temporibus florem aut in calamo constringunt aut decutiunt.[1]

25. Flante Austro anhelitus hominum magis fœtet, appetitus animalium dejicitur magis, morbi pestilentes grassantur, gravedines incumbunt, homines magis pigri sunt et hebetes: at flante Borea, magis alacres, sani, avidiores cibi.[2] Phthisicis tamen nocet Boreas, et tussiculosis, et podagricis, et omni fluxui acuto.

26. Eurus siccus, mordax, mortificans; Zephyrus humidus, clemens, almus.

27. Eurus, spirans vere adulto, calamitas fructuum, inducendo erucas et vermes, ut vix foliis parcatur; nec æquus admodum segetibus. Zephyrus contra, herbis, floribus, et omni vegetabili, maxime propitius et amicus. At Eurus quoque, circa æquinoctium autumnale, satis gratiosus.

28. Venti ab occidente spirantes, sunt vehementiores quam illi ab oriente, et magis curvant et contorquent arbores.

29. Tempestas pluviosa quæ incipit spirante Euro longius durat quam quæ spirante Zephyro, et fere ad diem integrum extenditur.

30. Eurus ipse, et Boreas, postquam inceperint flare, constantius flant: Auster et Zephyrus magis mutabiles.

31. Flante Euro visibilia omnia majora apparent[3]; at flante Zephyro audibilia; etiam longius deferuntur soni.

32. *Cæciam nubes ad se trahere*[4], apud Græcos in proverbium transiit, comparando ei fœneratores, qui pecunias erogando sorbent. Vehemens est ventus et latus, ut non possit summovere nubes tam cito, quam illæ renitantur et se vertant; quod fit etiam in majoribus incendiis, quæ contra ventum invalescunt.

33. Venti Cardinales, aut etiam Semicardinales, non sunt tam procellosi quam Mediani.

34. Mediani a Borea ad Euro-Boream magis sereni, ab Euro-Borea ad Eurum magis procellosi. Similiter ab Euro ad Euro-Austrum magis sereni, ab Euro-Austro ad Austrum magis procellosi. Similiter ab Austro ad Zephyro-Austrum

[1] Pliny, xviii. 17.
[2] Arist. Probl. § De Ventis, 18. 44. and 45.
[3] Arist. ubi supra, 55.
[4] Id. ib. 1. and 32. And compare Erasmus, *Adag.* i. 5. 62.

magis sereni, a Zephyro-Austro ad Zephyrum magis procellosi. Similiter a Zephyro ad Zephyro-Boream magis sereni, a Zephyro-Borea ad Boream magis procellosi. Ita ut progrediendo secundum ordinem cœli, semper Mediani prioris Semicardinis disponantur ad serenitatem; posterioris, ad tempestates.

35. Tonitrua, et fulgura, et Ecnephiæ fiunt spirantibus ventis frigidis, quique participant ex Borea, quales sunt Corus, Thrascias, Circias, Meses, Cæcias; ideoque fulgura sæpius comitatur grando.

36. Etiam nivales venti a septentrione veniunt, sed ab iis Medianis qui non sunt procellosi, veluti Corus et Meses.

37. Omnino venti quinque modis naturas suas et proprietates nanciscuntur. Vel ab absentia aut præsentia solis; vel a consensu et dissensu cum naturali motu aëris; vel a diversitate materiæ fomitum suorum a quibus generantur, maris, nivis, paludum, &c.; vel a tinctura regionum per quas pertranseunt; vel ab originibus localibus suis, in alto, sub terra, in medio; quæ omnia sequentes articuli melius explanabunt.

38. Venti omnes habent potestatem desiccandi, etiam magis quam ipse sol; quia sol vapores elicit, sed, nisi admodum ferveṇs fuerit, non dissipat; at ventus eos et elicit et abducit[1]; attamen Auster minime omnium hoc facit; quinetiam saxa et trabes sudant magis flante nonnihil Austro, quam in tranquillo.

39. Martii magis longe desiccant, quam æstivi; adeo ut artifices instrumentorum musicorum ventos Martios expectent ad materiam instrumentorum suorum desiccandam, eamque reddendam porosam et sonoram.[2]

40. Venti omnis generis purgant aërem, eumque a putredine vindicant, ut anni in quibus venti frequentius spirent sint maxime salubres.

41. Sol principum fortunam subit; quibuscum ita sæpe agitur, ut præsides in provinciis remotis magis obnoxios habeant subditos, et quibus obsequia præstentur magis quam principi ipsi. Certe venti, qui potestatem et originem habent a sole, æque aut plus gubernant temperaturas regionum et affectus

[1] Arist. Probl. § De Ventis, 31.

[2] "Ineunte vere . . . . venti longe plus corpora exsiccant celeriusque quam mediâ æstate, quare artifices nostri musici et materiales ventos expetunt, ad materiam et opificia varia confirmanda."— *Gilbert, Physiol.* iv. 3. Materiales is clearly a wrong reading for martiales, the *et* being afterwards introduced to improve the sense: *expetunt* ought to be *expectant*.

aëris quam ipse sol, in tantum ut Peruvia (quæ propter propinquitatem oceani, vastitatem amnium, et altissimos et maximos montes nivales, maximam habet copiam ventorum et aurarum spirantium) cum Europa de temperamento et clementia aëris certet.[1]

42. Nil mirum si ventorum tantus sit impetus quantus invenitur, quandoquidem venti vehementes sint tanquam inundationes atque torrentes et fluctus magni aëris. Neque tamen, si attentius advertas, magnum quiddam est eorum potentia. Possunt dejicere arbores, quæ cacuminum onere, tanquam velis expansis, iisdem commoditatem præbent, et se ipsæ onerant; possunt etiam ædificia infirmiora; sed structuras solidiores, nisi fiant cum terræ motibus, non subvertunt. Nives quandoque tanquam integras dejiciunt ex montibus, ut planitiem subjacentem fere sepeliant, quod accidit Solymanno in campis Sultaniæ; etiam magnas quandoque immittunt inundationes aquarum.[2]

43. Amnes quandoque tanquam in sicco ponunt venti, et fundos ipsorum discooperiunt. Si enim, post magnam siccitatem, ventus robustus in consecutione fili aquæ pluribus diebus spirarit, ita ut aquas amnis, tanquam everrendo, devexerit in mare, aquas marinas prohibuerit; fit siccatio amnis in multis locis insolitis.

Monitum. Verte Polos, et verte simul observationes, quatenus ad Austrum et Boream. Cum enim absentia et præsentia solis in causa sit, variat pro ratione polorum. At illud constans res esse possit, quod plus sit maris versus Austrum, plus sit terræ versus Boream, quod etiam ad ventos non parum facit.

Monitum. Mille modis fiunt venti, ut ex inquisitione sequenti patebit; itaque in re tam varia figere observationes haud facile est. Attamen quæ a nobis posita sunt, pro certo plerunque obtinent.

Origines Locales Ventorum.

Ad Artic. 8. *Connexio.*

Ventorum Origines Locales nosse arduæ est inquisitionis, cum illud *unde* et *quo* ventorum ut res abdita etiam in Scripturis notata sit. Neque loquimur

[1] Acosta, Hist. des Indes, ii. 9. [2] Knolles, Hist. of the Turks (1603), p. 650

jam de fontibus ventorum particularium (de quibus postea), sed de matricibus ventorum in genere. Alii ex alto eas petunt, alii in profundo rimantur; in medio autem, ubi ut plurimum generantur, vix eas quærunt; ut est mos hominum quæ ante pedes posita sunt præterire, et obscuriora malle. Illud liquet, ventos aut indigenas aut advenas esse; sunt enim venti tanquam *mercatores vaporum*, eosque in nubes collectos et important in regiones et exportant, unde iterum venti, tanquam per permutationem. Sed inquiramus jam de nativis. Qui enim aliunde advenæ, alibi nativi. Tres igitur Origines Locales; aut expirant et scaturiunt e terra; aut dejiciuntur ex sublimi; aut conflantur hic in corpore aëris. Qui autem dejiciuntur ex alto, duplicis generationis; aut enim dejiciuntur antequam formentur in nubes, aut postea ex nubibus rarefactis et dissipatis. Videamus quæ sit harum rerum *historia*.

1. Finxerunt poëtæ, regnum Æoli in antris et cavernis sub terram fuisse collocatum, ubi Carcer esset ventorum, qui subinde emittebantur.[1]

2. Etiam Theologos quosdam, eosdemque Philosophos, movent Scripturæ verba: *Qui producit ventos de thesauris suis*[2]: tanquam venti prodirent ex locis thesaurariis, subterraneis scilicet, ubi sunt mineræ; sed hoc nihil est. Nam loquitur etiam Scriptura de thesauris nivis et grandinis, quas in sublimi generari nemo dubitat.

3. In subterraneis proculdubio magna existit aëris copia, eamque et expirare sensim verisimile, et emitti confertim aliquando, urgentibus causis, necesse est.

Phænomenon obliquum. In magnis siccitatibus et media æstate, cum magis rimosa sit terra, solet erumpere in locis aridis et arenosis magna vis aquarum. Quod si faciant aquæ (corpus crassum) raro; aërem (corpus tenue et subtile) hoc frequenter facere probabile est.

4. Si expirat aër e terra sensim et sparsim, parum percipitur primo; sed postquam aëris illius emanationes multæ minutæ

[1] Æn. i. 50. sqq.—*J. S.*

[2] Bacon refers to Acosta, ubi suprà [lii. 2.], who however does not say that these treasure-houses are subterraneous. [I do not know why we should suppose the allusion to be to Acosta, who, though he quotes the passage, quotes it in another sense.— *J. S.*]

confluxerint, tum fit ventus; ut ex scaturiginibus aquarum rivus. Hoc vero ita fieri videtur; quoniam notatum est ab antiquis, ventos complures in ortu suo et in locis a quibus oriuntur primo spirare exiguos, deinde in progressu invalescere prorsus, more fluviorum.[1]

5. Inveniuntur quædam loca in mari, ac etiam lacus, qui, nullis flantibus ventis, majorem in modum tumescunt; ut hoc a subterraneo flatu fieri appareat.

6. Magna vis requiritur spiritus subterranei, ut terra concutiatur aut scindatur; levior, ut aqua sublevetur. Itaque tremores terræ rari; tumores et sublevationes aquarum frequentiores.

7. Etiam ubique notatum est, nonnihil attolli et tumescere aquas ante tempestates.

8. Spiritus subterraneus exilis qui sparsim efflatur, non percipitur super terram donec coierit in ventum, ob porositatem terræ[2]; sed exiens subter aquas, ob continuitatem aquæ statim percipitur ex tumore nonnullo.

9. Asseclas esse ventos terrarum cavernosarum antea posuimus; ut prorsus videantur venti illi habere Origines suas Locales e terra.

10. In montibus magnis et saxeis inveniuntur venti et citius spirare (antequam scilicet percipiantur in vallibus), et frequentius (cum scilicet valles sint in tranquillo); at omnes montes et rupes cavernosi sunt.

11. In comitatu *Denbigh*[3] in Britannia, montosa regione et lapidosa, ex cavernis quibusdam tam vehementes (ait Gilbertus[4]) sunt ventorum eruptiones, ut injecta vestimenta pannique rursus magna vi efflentur, et altius in aërem efferantur.

12. In *Aber Barry* juxta Sabrinam in Wallia, in quodam clivo saxoso in quo sunt foramina, si quis aurem apposuerit, sonitus varios et murmur flatuum sub terra exaudiet.

Phænomenon obliquum.

Notavit Acosta, oppida Platæ et Potosæ in Peruvia non longe esse distantia, et utrumque situm esse in terra elevata aut montana, ut in hoc non differant; et nihilominus habere Potosam temperaturam aëris frigidam et hiemalem, Platam clementem et vernam[5];

[1] Compare Gilbert, Physiol. iv. 2.

[2] "Exeunt ergo a terrâ per poros insensibili transpiratione venti."—*Gilbert*, ubi suprà; from whom §§ 11. and 12. are taken.

[3] The true reading is preserved in Gilbert: *Derbiæ*.

[4] De Mundo, iv. 2.

[5] Acosta. ubi sup. ii. 13.

id quod videtur argenti fodinis juxta Potosam attribui posse; quod demonstrat esse spiracula terræ, quatenus ad calidum et frigidum.

13. Si terra sit primum frigidum, ut voluit Parmenides[1] (non contemnenda usus sententia, cum frigus et densitas arcto copulentur vinculo), non minus probabile est ejici halitus calidiores a frigore centrali terræ, quam dejici a frigore aëris sublimioris.

14. Sunt quidam putei in Dalmatia et regione Cyrenaica, ut quidam ex antiquis memorant, in quibus si dejiciatur lapis, excitantur paulo post tempestates[2]; ac si lapis perfringeret operculum aliquod in loco ubi vis ventorum erat incarcerata.

Phænomenon obliquum. Flammas evomunt Ætna, et complures montes; similiter et aërem erumpere posse consentaneum est, præsertim calore in subterraneis dilatatum et in motu positum.

15. In terræ motibus, ventos quosdam noxios et peregrinos, et ante eruptionem et postea, flare observatum est; ut fumi quidam minores solent emitti ante et post incendia magna.

Monitum. Aër in terra conclusus erumpere ob varias causas compellitur. Quandoque massa terræ male coagmentata in cavum terræ decidit; quandoque aquæ se ingurgitant; quandoque expanditur aër per ignes subterraneos, ut ampliorem locum quærat; quandoque terra, quæ antea solida erat et concamerata, per ignes in cineres versa, se amplius sustinere non potest, sed decidit; et complura id genus.

Atque de prima Origine Locali Ventorum, videlicet e subterraneis, hæc inquisita sunt. Sequitur origo secunda, ex sublimi; nempe media, quam appellant, regione aëris.

Monitum. At nemo tam male quæ dicta sunt intelligat, quasi negemus et reliquos ventos e terra et mari per vapores educi. Sed hoc prius genus erat ventorum qui exeunt e terra jam venti formati.

16. Increbrescere murmur sylvarum antequam manifesto percipiantur venti, notatum est[3]; ex quo conjicitur ventum a superiore loco descendere; quod etiam observatur in montibus (ut dictum est), sed causa magis ambigua, propter cava montium.

17. Stellas sagittantes (ut loquimur) et vibratas sequitur

[1] Arist. Metaph. l. 5. [2] Pliny, ii. 44. [3] Pliny, xviii. 66.

ventus[1]; atque etiam ex ea parte, ex qua fit jaculatio; ex quo patet aërem in alto commotum esse, antequam ille motus perveniat ad nos.

18. Apertio cœli, et disgregatio nubium, præmonstrat ventos, antequam flent in terra; quod itidem ostendit ventos inchoari in alto.

19. Stellæ exiguæ, antequam oriatur ventus, non cernuntur, licet nocte serena[2]; cum scilicet (ut videtur) densetur, et fit[3] minus diaphanus aër, propter materiam quæ postea solvitur in ventos.

20. Circuli apparent circa corpus lunæ; sol quandoque occidens conspicitur sanguineus; luna rubicundior est in ortu quarto; et complura alia inveniuntur prognostica ventorum in sublimi (de quibus suo loco dicemus); quæ indicant materiam ventorum ibi inchoari et præparari.

21. In istis phænomenis notabis illam de qua diximus differentiam, de duplici generatione ventorum in sublimi; nimirum ante congregationem vaporum in nubem, et post. Nam prognostica halonum, et colorum solis et lunæ, habent aliquid ex nube; at jaculatio illa et occultatio stellarum exiguarum fiunt in sereno.

22. Cum ventus prodit a nube formata, aut totaliter dissipatur nubes, et vertitur in ventum; aut secernitur, partim in pluviam, partim in ventum; aut scinditur, et erumpit ventus, ut in procella.

23. Plurima sunt Phænomena Obliqua ubique in natura rerum de repercussione per frigidum; itaque cum constet esse in media regione aëris frigora valde intensa, planum fit, vapores maxima ex parte ea loca perfringere non posse, quin aut coagulentur aut vibrentur; secundum opinionem veterum, in hac parte sanam.

Tertia Origo Localis Ventorum est eorum, qui hic in inferiore aëre generantur, quos etiam tumores sive super-onerationes aëris appellamus. Res maxime familiaris, et tamen silentio transmissa.

Commentatio. Horum ventorum qui conflantur in aëre infimo generatio abstrusior aliqua res non est, quam hæc ipsa; quod

[1] Arist. Prob. xxvi, 25.; and comp. Pliny, xviii. 80.
[2] Pliny, ubi suprà.
[3] So in the original.—*J. S*

scilicet aër noviter factus ex aqua et vaporibus attenuatis et resolutis, conjunctus cum aëre priore, non potest contineri iisdem quibus antea spatiis, sed excrescit et volvitur et ulteriora loca occupat. Hujus tamen rei duo sunt assumpta. Unum, quod gutta aquæ in aërem versa (quicquid de *decima proportione elementorum* fabulentur) centuplo ad minus plus spatii desiderat, quam prius; alterum, quod parum aëris novi et moti, superadditum aëri veteri, totum concutit et in motu ponit: ut videre est ex pusillo vento, qui ex follibus aut rima fenestræ efflat, qui tamen totum aërem in cubiculo in motu ponere possit; ut ex flammis lucernarum facile apparet.

24. Quemadmodum rores et nebulæ hic in aëre infimo generantur, nunquam factæ nubes, nec ad mediam regionem penetrantes; eodem modo et complures venti.

25. Aura continua spirat circa maria et aquas, quæ est ventus pusillus noviter factus.

26. Iris, quæ est ex meteoris quasi humillima et generatur in proximo, quando non conspicitur integra, sed curtata, et quasi frusta ejus tantum in cornibus, solvitur in ventos æque ac in pluviam, et magis.

27. Notatum est, esse quosdam ventos in regionibus quæ disterminantur et separantur per montes intermedios, qui ex altera parte montium spirant familiares, ad alteram non perveniunt[1]; ex quo manifestum, eos generari infra altitudinem ipsorum montium.

28. Infiniti sunt venti, qui spirant diebus serenis, atque etiam in regionibus ubi nunquam pluit; qui generantur ubi flant, nec unquam erant nubes, aut in mediam regionem ascenderunt.

Phænomena obliqua. Quicunque norit quam facile vapor solvatur in aërem, et quam ingens sit copia vaporum, et quantum spatium occupet gutta aquæ versa in aërem præ eo quod antea occupabat (ut dictum est), et quam modicum sustineat se comprimi aër, non dubitabit quin necesse sit, etiam a superficie terræ usque ad sublimia aëris, ubique generari ventos. Neque enim fieri potest, ut magna copia vaporum, cum cœperint expandi, ad mediam aëris regionem attollantur, absque superoneratione aëris et tumultu in via.

[1] Gilbert, Phys. lv. 1.

Accidentales Generationes Ventorum.

Ad Art. 9. *Connexio.* Accidentales Generationes ventorum eas vocamus, quæ non efficiunt aut gignunt motum impulsivum ventorum, sed eum compressione acuunt, repercussione vertunt, sinuatione agitant et volvunt: quod fit per causas extrinsecas et posituram corporum adjunctorum.

1. In locis ubi sunt colles minus elevati, et circa hos subsidunt valles, et ultra ipsos rursus colles altiores, major est agitatio aëris et sensus ventorum, quam aut in montanis aut in planis.

2. In urbibus, si sit aliquis locus paulo latior, et exitus angustiores, aut angiportus, et plateæ se invicem secantes, percipiuntur ibi flatus et auræ.

3. In ædibus refrigeratoria per ventos fiunt aut occurrunt, ubi aër est perflatilis, et ex una parte introit aër, ex adverso exit; sed multo magis, si aër intrat ex diversis partibus, et facit concursum auræ ad angulos, et habet exitum illi angulo communem. Etiam concameratio cœnaculorum, et rotunditas, plurimum facit ad auras, quia repercutitur aër commotus ad omnes lineas. Etiam sinuatio porticuum magis juvat, quam si exporrigantur in recto; flatus enim in recto, licet non concludatur, sed liberum habeat exitum, tamen non reddit aërem tam inæqualem et voluminosum et undantem, quam confluxus ad angulos et anfractus et glomerationes in rotundo, et hujusmodi.

4. Post magnas tempestates in mari continuatur ventus Accidentalis ad tempus, postquam Originalis resederit; factus ex collisione et percussione aëris per undulationem fluctuum.

5. Reperitur vulgo in hortis repercussio venti a parietibus et ædibus et aggeribus; ita ut putaret quis ventum in contrariam partem spirare ejus a qua revera spirat.

6. Si montes regionem aliqua ex parte cingant, et ventus paulo diutius ex plano contra montem spiraverit, fit ut ipsa repercussione montis aut contrahatur ventus in pluviam, si fuerit humidior, aut vertatur in ventum contrarium, sed qui brevi tempore duret.

7. In flexionibus promontoriorum experiuntur nautæ sæpius mutationes ventorum.[1]

[1] Gilbert, ubi suprà.

Venti Extraordinarii, et Flatus Repentini.

Ad Art. 10. *Connexio.*

De ventis Extraordinariis sermocinantur quidam et causantur; Ecnephia sive Procella, Vortice, Typhone[1], Prestere: sed rem non narrant, quæ certe ex chronicis et historia sparsa peti debet.

1. Repentini Flatus nunquam cœlo sereno fiunt, sed semper nubilo et cum imbre; ut eruptionem quandam fieri, et flatum excuti, aquas concuti, recte putetur.

2. Procellæ quæ fiunt cum nebula aut caligine, quas belluas vocant, quæque se sustinent instar columnæ, vehementes admodum sunt, et diræ navigantibus.

3. Typhones majores, qui per latitudinem aliquam notabilem corripiunt, et correpta sorbent in sursum, raro fiunt; at Vortices, sive Turbines exigui, et quasi ludicri, frequenter.

4. Omnes Procellæ, et Typhones, et Turbines majores, habent manifestum motum præcipitii aut vibrationis deorsum, magis quam alii venti; ut torrentum modo ruere videantur, et quasi per canales defluere, et postea a terra reverberari.

5. Fit in pratis, ut cumuli fœni quandoque in altum ferantur, et tum instar conopei spargantur; etiam in agris, ut caules pisarum involuti[2], et aristæ segetum demessæ, quinetiam lintea ad exsiccandum exposita, attollantur a Turbinibus usque ad altitudinem arborum, aut supra fastigia ædium; hæcque fiunt absque aliquo majore venti impetu aut vehementia.

6. At quandoque fiunt Turbines leves et admodum angusti, etiam in sereno; ita ut equitans videat pulveres vel paleas corripi et verti prope se, neque tamen ipse magnopere ventum sentiat; quæ proculdubio fiunt hic prope, ex auris contrariis se mutuo repellentibus, et circulationem aëris ex concussione facientibus.

7. Certum est, esse quosdam flatus qui manifesta vestigia relinquunt adustionis et torrefactionis in plantis. At Presterem, qui est tanquam fulgur cæcum, atque aër fervens, sed sine flamma, ad inquisitionem de fulgure rejicimus.

[1] It is curious that the name given to the hurricanes of the China seas, typhoons, has only an accidental resemblance to the Greek word *τύφων*. It is a corruption of the Chinese phrase Tãe-Foong, Great wind. See Davis's *Chinese*, vol. iii. p. 142. of Knight's edition.

[2] *Involutæ* in the original.—*J. S.*

Confacientia ad Ventos; Originales scilicet; nam de Accidentalibus supra inquisitum est.

Ad Art. 11, 12, 13, 14, 15. *Connexio.* Quæ a veteribus de ventis eorumque causis dicta sunt, confusa plane sunt et incerta, nec maxima ex parte vera. Neque mirum si non cernant clare, qui non spectant prope. Loquuntur ac si ventus aliud quippiam esset, separatum ab aëre moto; atque ac si exhalationes generarent et conficerent corpus integrum ventorum; atque ac si materia ventorum esset exhalatio tantum calida et sicca[1]; atque ac si origo motus ventorum esset tantummodo dejectio et percussio a frigore mediæ regionis: omnia phantastica et pro arbitrio. Attamen ex hujusmodi filis magnas conficiunt telas; *operas* scilicet *aranearum*. At omnis impulsio aëris est Ventus; et exhalationes permistæ aëri plus conferunt ad motum quam ad materiam; et vapores humidi, ex calore proportionato, etiam facilius solvuntur in ventum quam exhalationes siccæ; et complures venti generantur in regione infima aëris, et ex terra expirant, præter illos qui dejiciuntur et repercutiuntur. Videamus qualis sit sermo rerum ipsarum.

1. Rotatio naturalis aëris (ut dictum est in articulo de ventis Generalibus), absque causa alia externa, gignit ventum perceptibilem intra tropicos, ubi aëris conversio fit per circulos majores.

2. Post motum aëris naturalem, antequam inquiramus de sole qui est genitor ventorum præcipuus, videndum num quid sit tribuendum lunæ et aliis astris, ex experientia clara.

3. Excitantur venti magni et fortes nonnullis ante Eclipsin Lunæ horis; ita ut si luna deficiat medio noctis, flent venti vesperi præcedente; si luna deficiat mane, flent venti medio noctis præcedente.

4. In Peruvia, quæ regio est admodum flatilis, notat Acosta maxime flare ventos in Pleniluniis.[2]

[1] Arist. Meteorolog. ii. 4. But it had been affirmed before Aristotle that wind is only air in motion. See the *Meteorol.* i. 13.; and compare Olympiod. in loc., who ascribes this opinion to Hippocrates. See Ideler's edition of the *Meteorol.* vol. i. p. 241.

[2] "Il y en a aucuns qui y ayant faict (that is, in Peru and the neighbouring countries) quelque résidence disent que la plus grande abondance des pluyes est quand la lune est en son plein, encore que, pour dire la vérité, je non ay pui faire preuve suffisante, bien que j'y aye prins garde quelquefois."—*Hist. des Indes.* ii. 7. This is all that Acosta says of the influence of the moon on the weather, and it certainly does not justify the text.

Mandatum. Dignum certe esset observatione, quid possint super ventos motus et tempora lunæ, cum liquido possint super aquas; veluti, utrum venti non sint paulo commotiores in Pleniluniis et Noviluniis quam in dimidiis, quemadmodum fit in æstibus aquarum; licet enim quidam commode fingant imperium Lunæ esse super Aquas, Solis vero et Astrorum super Aërem; tamen certum est aquam et aërem esse corpora valde homogenea; et Lunam, post Solem, plurimum hic apud nos posse in omnibus.

5. Circa Conjunctiones Planetarum non fugit hominum observationem flare ventos majores.

6. Exortu Orionis surgunt plerunque venti et tempestates variæ [1]; sed videndum, annon hoc fiat quia exortus ejus sit eo tempore anni quod ad generationem ventorum est maxime efficax; ut sit potius concomitans quiddam, quam causa; quod etiam de ortu Hyadum et Pleiadum quoad imbres, et Arcturi quoad tempestates, similiter merito dubitari possit. De Luna et Stellis hactenus.

7. Sol proculdubio est efficiens primarius ventorum plurimorum, operans per calorem in materiam duplicem; corpus scilicet aëris, et vapores sive exhalationes.

8. Sol, cum est potentior, aërem, licet purum et absque immistione ulla, dilatat fortasse ad tertiam partem, quæ res haud parva est. Itaque per simplicem dilatationem, necesse est ut oriatur aura aliqua in viis solis, præsertim in magnis fervoribus; idque potius duas aut tres horas post exortum ejus, quam ipso mane.

9. In Europa noctes sunt æstuosiores; in Peruvia tres horæ matutinæ [2]; ob unam eandemque causam; videlicet cessationem aurarum et ventorum illis horis.

10. In *vitro calendari* aër dilatatus deprimit aquam tanquam flatu; at in *vitro pileato*, aëre tantummodo impleto, aër dilatatus inflat vesicam ut ventus manifestus.

[1] Arist. Problem. De Ventis, 14. He must be understood to speak of the evening rising of Orion; at the heliacal rising there was, on the contrary, a season of fine weather. See Arist. *Meteor.* ii. 5., and Ideler's *Commentary*. The morning setting of the Pleiades was supposed to mark the beginning of winter; that of the Hyades took place a little later. Fair weather generally returned, Pliny says, after their heliacal setting. They were popularly called Sidus Palilicium, because the Palilia were celebrated about that time. The heliacal rising of Arcturus was generally accompanied, according to Pliny, by storms. It is to be remarked that Bacon does not seem to have been aware that phenomena of the class here referred to occur at different times in the year, under different parallels of latitude and in different ages.

[2] Acosta, Hist. des Indes, ii. 13.

11. Experimentum fecimus in turri rotunda, undique clausa, hujus generis venti. Nam foculum in medio ejus locavimus, cum prunis penitus ignitis, ut minus esset fumi; at a latere foculi in distantia nonnulla filum suspendimus, cum cruce ex plumis, ut facile moveretur. Itaque post parvam moram, aucto calore et dilatato aëre, agitabatur crux plumea cum filo suo, hinc inde, motu vario; quinetiam facto foramine in fenestra turris, exibat flatus calidus, neque ille continuus, sed per vices, et undulans.

12. Etiam receptio aëris per frigus a dilatatione creat ejusmodi ventum, sed debiliorem, ob minores vires frigoris; adeo ut in Peruvia, sub quavis parva umbra, non solum majus percipiatur refrigerium quam apud nos (per *antiperistasin*), sed manifesta aura ex receptione aëris quando subit umbram.[1]

Atque de vento per meram dilatationem aut receptionem aëris facto, hactenus.

13. Venti ex meris motibus aëris, absque immistione vaporum, lenes et molles sunt. Videndum de ventis Vaporariis (eos dicimus qui generantur a vaporibus), qui tanto illis alteris possunt esse vehementiores, quanto dilatatio guttæ aquæ versæ in aërem excedit aliquam dilatationem aëris jam facti: quod multis partibus facit, ut superius monstravimus.

14. Ventorum Vaporariorum (qui sunt illi qui communiter flant) efficiens est Sol, et calor ejus proportionatus; materia, vapores et exhalationes qui vertuntur et resolvuntur in aërem; aërem inquam (non aliud quippiam ab aëre) sed tamen ab initio minus sincerum.

15. Solis calor exiguus non excitat vapores, itaque nec ventum.

16. Solis calor medius excitat vapores, nec tamen eos continuo dissipat. Itaque si magna fuerit ipsorum copia, coëunt in pluviam, aut simplicem, aut cum vento conjunctam; si minor, vertuntur in ventum simplicem.

17. Solis calor in incremento inclinat magis ad generationem ventorum; in decremento, pluviarum.

18. Solis calor intensus et continuatus attenuat et dissipat vapores, eosque sublimat, atque interim aëri æqualiter immiscet et incorporat; unde aër quietus fit et serenus.

19. Calor Solis magis æqualis et continuus, minus aptus ad generationem ventorum; magis inæqualis et alternans, magis

[1] Acosta, ubi suprà.

aptus. Itaque in navigatione ad Russiam minus afflictantur ventis quam in mari Britannico, propter longos dies; at in Peruvia sub æquinoctio crebri venti; ob magnam inæqualitatem caloris, alternantem noctu et interdiu.

20. In vaporibus et copia spectatur et qualitas: copia parva gignit auras lenes; media ventos fortiores; magna aggravat aërem, et gignit pluvias, vel tranquillas[1] vel cum ventis.

21. Vapores ex mari, et amnibus, et paludibus inundatis, longe majorem copiam gignunt ventorum, quam halitus terrestres. Attamen, qui a terra et locis minus humidis gignuntur venti, sunt magis obstinati et diutius durant, et[2] sunt illi fere qui dejiciuntur ex alto; ut opinio veterum in hac parte non fuerit omnino inutilis; nisi quod placuit illis, tanquam divisa hæreditate, assignare vaporibus pluvias, et ventis solummodo exhalationes; et hujusmodi pulchra dictu, re inania.[3]

22. Venti ex resolutionibus nivium jacentium super montes sunt fere medii inter ventos aquaticos et terrestres, sed magis inclinant ad aquaticos; sed tamen sunt acriores et mobiliores.

23. Solutio nivium in montibus nivalibus (ut prius notavimus) semper inducit ventos Statos ex ea parte.

24. Etiam Anniversarii Aquilones circa exortum Caniculæ[4] existimantur venire a Mari Glaciali et partibus circa circulum Arcticum, ubi seræ sunt solutiones glaciei et nivium, æstate tum valde adulta.

25. Moles sive montes glaciales, quæ devehuntur versus Canadam et Terram Piscationis, magis gignunt auras quasdam frigidas quam ventos mobiles.

26. Venti qui ex terris sabulosis aut cretaceis proveniunt sunt pauci et sicci; iidem in regionibus calidioribus æstuosi, et fumei, et torridi.

27. Venti ex vaporibus marinis facilius abeunt retro in pluviam, aqua jus suum repetente et vindicante; aut si hoc non conceditur, miscentur protinus aëri, et quietem agunt. At halitus terrei, et fumei, et unctuosi, et solvuntur ægrius, et ascendunt altius, et magis irritati sunt in suo motu, et sæpe penetrant mediam regionem aëris, et sunt aliqua materia meteororum ignitorum.

28. Traditur apud nos in Anglia, temporibus cum Gasconia esset hujus ditionis, exhibitum fuisse regi libellum supplicem

[1] *Tranquillos* in the original.—*J. S.*
[2] So in the original.—*J. S.*
[3] See Arist. ubi suprà.
[4] See Pliny, ii.

per subditos suos Burdegaliæ[1] et confinium; petendo ut prohiberetur incensio ericæ in agris Sussexiæ et Hamptoniæ, quia gigneret ventum circa finem Aprilis vineis suis exitiabilem.

29. Concursus ventorum ad invicem, si fuerint fortes, gignunt ventos vehementes et vorticosos; si lenes et humidi, gignunt pluviam, et sedant ventos.

30. Sedantur et coërcentur venti quinque modis: cum aut aër, vaporibus oneratus et tumultuans, liberatur, vaporibus se contrahentibus in pluviam; aut cum vapores dissipantur et fiunt subtiliores, unde permiscentur aëri, et belle cum ipso conveniunt, et quiete degunt; aut cum vapores sive halitus exaltantur et sublimantur in altum, adeo ut requies sit ab ipsis, donec a media regione aëris dejiciantur aut eam penetrent; aut cum vapores, coacti in nubes, ab aliis ventis in alto spirantibus transvehuntur in alias regiones, ut pax sit ab ipsis in regionibus quas prætervolant; aut denique, cum venti a fomitibus suis spirantes, longo itinere, nec succedente nova materia, languescunt, et impetu suo destituuntur, et quasi expirant.

31. Imbres plerunque ventos sedant, præsertim procellosos, ut et venti contra sæpius detinent imbrem.

32. Contrahunt se venti in pluviam (qui est primus ex quin que sedandi modis, isque præcipuus) aut ipso onere gravati cum vapores sint copiosi; aut propter contrarios motus ventorum, modo sint placidi; aut propter obices montium et promontoriorum, quæ sistunt impetum ventorum, eosque paulatim in se vertunt; aut per frigora intensiora, unde condensantur.

33. Solent plerunque venti minores et leviores mane oriri et cum sole decumbere, sufficiente condensatione aëris nocturna ad receptionem eorum. Aër enim nonnullam compressionem patitur absque tumultu.

34. Sonitus campanarum existimatur tonitrua et fulgura dissipare; de ventis non venit in observationem.

Monitum. Consule locum de Prognosticis ventorum; est enim nonnulla connexio causarum et signorum.

35. Narrat Plinius, Turbinis vehementiam aspersione aceti in occursum ejus compesci.[2]

[1] Bordeaux. This story is mentioned by Haller, *Biblioth. Medic.* in Bacon.
[2] Pliny, ii. 49.

Limites Ventorum.

Ad Art. 16, 17, 18.

1. Traditur de monte Atho, et similiter de Olympo, consuevisse sacrificantes, in aris super fastigia ipsorum extructis, literas exarare in cineribus sacrificiorum, et postea redeuntes elapso anno (nam anniversaria erant sacrificia) easdem literas reperisse neutiquam turbatas aut confusas; etiamsi aræ illæ non starent in templo aliquo, sed sub dio.[1] Unde manifestum erat, in tanta altitudine neque cecidisse imbrem, neque spirasse ventum.

2. Referunt in fastigio Pici de Tenariph, atque etiam in Andibus inter Peruviam et Chilem, nives subjacere per clivos et latera montium; at in ipsis cacuminibus nil aliud esse quam aërem quietum, vix spirabilem propter tenuitatem[2], qui etiam acrimonia quadam et os stomachi et oculos pungat, inducendo illi nauseam, his suffusionem et ruborem.

3. Venti Vaporarii non videntur in aliqua majore altitudine flare; cum tamen probabile sit aliquos ipsorum altius ascendere quam pleræque nubes.

De Altitudine hactenus, de Latitudine videndum.

4. Certum est, spatia quæ occupant venti admodum varia esse, interdum amplissima, interdum pusilla et angusta. Deprehensi sunt venti occupasse spatium centenorum milliarium, cum paucarum horarum differentia.

5. Spatiosi venti (si sint ex liberis) plerunque vehementes sunt, non lenes. Sunt etiam diuturniores, et fere 24 horas durant. Sunt itidem minus pluviosi. Angusti contra, aut lenes sunt aut procellosi; at semper breves.

6. Stati venti sunt itinerarii, et longissima spatia occupant.

7. Venti Procellosi non extenduntur per larga spatia, licet semper evagentur ultra spatia ipsius procellæ.

8. Marini venti intra spatia angustiora multo quam terrestres spirant; in tantum, ut in mari aliquando conspicere detur auram

[1] See Arist. Prob. xxvi. 39.; and for Olympus, Solinus Polyhist. 15. The same circumstance is told of Cyllene in Arcadia by Geminus, and, on the authority of Alexander Aphrodisiensis, by Olympiodorus. See Ideler's edition of Arist. *Meteor.* i. p. 148. and 355. The passage in Solinus seems to have escaped him. It is the only one in which Olympus is mentioned. Bruno, in the *Cena di Cenere*, refers to Alexander Aphrodisiensis; not being aware perhaps that the story is not told in his Commentary on the Meteorologics. See on this point Ideler's note at i. p. 148.

[2] What is here said of the Andes is probably taken from Acosta, iii. 9. and 20. The account of the Peak of Teneriffe seems to be taken from the account which Scory, the "Knight of Teneriffe," gave of his own ascent to its summit. See Purchas, v. 785.

satis alacrem aliquam partem aquarum occupare (id quod ex crispatione aquæ facile cernitur) cum undique sit malacia, et aqua instar speculi plana.

9. Pusilli (ut dictum est) Turbines ludunt quandoque coram equitantibus, instar fere ventorum ex follibus.

De Latitudine hactenus, de Duratione videndum.

10. Durationes ventorum valde vehementium in mari longiores sunt, sufficiente copia vaporum; in terra vix ultra diem et dimidium extenduntur.

11. Venti valde lenes nec in mari nec in terra ultra triduum constanter flant.

12. Non solum Eurus Zephyro magis est durabilis (quod alibi posuimus), sed etiam quicunque ille ventus sit qui mane spirare incipit, magis durabilis solet esse illo qui surgit vesperi.

13. Certum est, ventos insurgere et augeri gradatim (nisi fuerint meræ Procellæ); at decumberre celerius, interdum quasi subito.

Successiones Ventorum.

Ad Art. 19, 20, 21. 1. Si ventus se mutet conformiter ad motu solis, id est, ab Euro ad Austrum, ab Austro ad Zephyrum, a Zephyro ad Boream, a Borea ad Eurum, non revertitur plerunque; aut si hoc facit, fit ad breve tempus. Si vero in contrarium motus solis, scilicet ab Euro ad Boream, a Borea ad Zephyrum, a Zephyro ad Austrum, ab Austro ad Eurum, plerunque restituitur ad plagam priorem, saltem antequam confecerit circulum integrum.[1]

2. Si pluvia primum inceperit, et postea cœperit flare ventus, ventus ille pluviæ superstes erit. Quod si primo flaverit ventus, postea a pluvia occiderit, non reoritur plerunque ventus; et si facit, sequitur pluvia nova.

3. Si venti paucis horis varient, et tanquam experiantur, et deinde cœperint constanter flare, ventus ille durabit in dies plures.

4. Si Auster cœperit flare dies duos vel tres, Boreas quandoque post eum subito spirabit. Quod si Boreas spiraverit

[1] Humboldt gives Bacon credit for being the first to state this law of rotation, of which Dool and others have recently made so much use in their meteorological theories. *Kosmos*, ii. p. 379.

totidem dies, non spirabit Auster donec ventus paulisper ab Euro flarit.[1]

5. Cum annus inclinarit, et post autumnum hiems inceperit, si incipiente hieme spiraverit Auster, et postea Boreas, erit hiems glacialis[2]; sin sub initiis hiemis spiraverit Boreas, postea Auster, erit hiems clemens et tepidus.

6. Plinius citat Eudoxum, quod series ventorum redeat post quadriennium[3]; quod verum minime videtur; neque enim tam celeres sunt revolutiones. Illud ex aliquorum diligentia notatum est, tempestates grandiores et insigniores (fervorum, nivium, congelationum, hiemum tepidarum, æstatum gelidarum) redire plerunque ad circuitum annorum triginta quinque.[4]

Motus Ventorum.

Ad Art. 22, 23, 24, 25, 26, 27. *Commercio.*

Loquuntur homines, ac si ventus esset corpus aliquod per se, atque impetu suo aërem ante se ageret et impelleret. Etiam cum ventus locum mutet, loquuntur ac si idem ventus se in alium locum transferret. Hæc vero cum loquuntur plebeii, tamen philosophi ipsi remedium hujusmodi opinionibus non præbent; sed et illi quoque balbutiunt, neque erroribus istis occurrunt.

1. Inquirendum igitur et de excitatione motus in ventis, et de directione ejus, cum de Originibus Localibus jam inquisitum sit. Atque de iis ventis qui habent principium motus in sua prima impulsione, ut in iis qui dejiciuntur ex alto aut efflant e terra, excitatio motus est manifesta; alteri sub initiis suis descendunt, alteri ascendunt, et postea ex resistentia aëris fiunt voluminosi, maxime secundum angulos violentiæ suæ. At de illis qui[5] conflantur ubique in aëre inferiore (qui sunt omnium ventorum frequentissimi) obscurior videtur inquisitio; cum

[1] Arist. Prob. xxvi. 49. [2] Id. ib. 48. [3] Plin. ii. 48.

[4] In Bacon's Essay, *Of the Vicissitude of Things*, this observation is mentioned as having been made in the Netherlands:—"There is a toy which I have heard, and I would not have it given over, but waited upon a little. They say it is observed in the Low Countries (I know not in what part) that every five and thirty years the same kind and suit of years and weathers comes about again; as great frosts, great wet, great droughts, warm winters, summers with little heat, and the like; and they call it the *Prime*. It is a thing I do the rather mention, because computing backwards I have found some concurrence."—*J. S.*

[5] *Quæ* in the original.—*J. S.*

tamen res sit vulgaris, ut in Commentatione sub articulo octavo declaravimus.[1]

2. Etiam hujus rei imaginem reperimus in illa turri occlusa, de qua paulo ante. Tribus enim modis illud experimentum variavimus. Primus erat is de quo supra diximus, foculus ex prunis ante ignitis et claris. Secundus erat lebes aquæ ferventis, remoto illo foculo; atque tum erat motus crucis plumeæ magis hebes et piger quam ex foculo prunarum; hærente in aere rore vaporis aquei, nec dissipato in materiam venti, propter imbecillitatem caloris. At tertius erat ex utrisque simul, foculo et lebete; tum vero longe maxima erat crucis plumeæ agitatio, adeo ut quandoque illam in sursum verteret, instar pusilli turbinis; aqua scilicet præbente copiam vaporis, et foculo, qui astabat, eum dissipante.

3. Itaque Excitationis motus in ventis causa est præcipua superoneratio aëris, ex nova accessione aëris facti ex vaporibus.

Jam de Directione motus videndum, et de Verticitate, quæ est Directionis mutatio.

4. Directionem motus progressivi ventorum regunt fomites sui, qui sunt similes fontibus amnium; loca scilicet ubi magna reperitur copia vaporum; ibi enim est *patria venti.* Postquam autem invenerint currentem ubi aër minime resistit, (sicut aqua invenit declivitatem,) tum quicquid inveniunt similis materiæ in via in consortium recipiunt, et suo currenti miscent; quemadmodum faciunt et amnes. Itaque venti spirant semper a parte fomitum suorum.

5. Ubi non sunt fomites insignes in aliquo loco certo, vagantur admodum venti, et facile currentem suum mutant; ut in medio mari et campestribus terræ latis.

6. Ubi magni sunt fomites ventorum in uno loco, sed in locis progressus sui parvæ accessiones, ibi venti fortiter flant sub initiis, et paulatim flaccescunt; ubi contra fomites magis continui, leniores sunt sub initiis, et postea augentur.

7. Sunt fomites mobiles ventorum, scilicet in nubibus; qui sæpe a ventis in alto spirantibus transportantur in loca procul distantia a fomitibus vaporum, ex quibus generatæ sunt illæ nubes; tum vero incipit esse fomes venti ex parte ubi nubes incipiunt solvi in ventum.

[1] Suprà, p. 42.—*J. S.*

8. At Verticitas ventorum non fit eo quod ventus prius flans se transferat; sed quod ille aut occiderit, aut ab altero vento in ordinem redactus sit. Atque totum hoc negotium pendet ex variis collocationibus fomitum ventorum, et varietate temporum quando vapores ex hujusmodi fomitibus manantes solvuntur.

9. Si fuerint fomites ventorum a partibus contrariis, veluti alter fomes ab Austro, alter a Borea, prævalebit scilicet ventus fortior, neque erunt venti contrarii, sed ventus fortior continuo spirabit; ita tamen ut a vento imbecilliore nonnihil hebetetur et dometur; ut fit in amnibus, accedente fluxu maris; nam motus maris prævalet, et est unicus, sed a motu fluvii nonnihil frænatur. Quod si ita acciderit, ut alter ex illis ventis contrariis, qui primum fortior fuerat, succumbat, tum subito spirabit ventus a parte contraria, unde et ante spirabat, sed latitabat sub potestate majoris.

10. Si fomes (exempli gratia) fuerit ad Euro-Boream, spirabit scilicet Euro-Boreas. Quod si fuerint duo fomites ventorum, alter ad Eurum, alter ad Boream, ii venti ad aliquem tractum spirabunt separatim; at post angulum confluentiæ spirabunt ad Euro-Boream, aut cum inclinatione, prout alter fomes fuerit fortior.

11. Si sit fomes venti ex parte Boreali, qui distet ab aliqua regione 20 milliaribus, et sit fortior; alter ex parte Orientali, qui distet 10 milliaribus, et sit debilior; spirabit tamen ad aliquas horas Eurus; paulo post (nimirum post emensum iter) Boreas.

12. Si spiret Boreas, atque occurrat ab occidente mons aliquis, spirabit paulo post Euro-Boreas, compositus scilicet ex vento originali et repercusso.

13. Si sit fomes ventorum in terra a parte Boreæ, halitus autem ejus feratur recta sursum, et inveniat nubem gelidam ab occidente quæ eam in adversum detrudat, spirabit Euro-Boreas.

Monitum. Fomites ventorum in terra et mari sunt stabiles, ita ut fons et origo ipsorum melius percipiatur; at fomites ventorum in nubibus sunt mobiles, adeo ut alibi suppeditetur materia ventorum, alibi vero ipsi formentur; id quod efficit directionem motus in ventis magis confusam et incertam.

Hæc exempli gratia adduximus; similia simili modo se habent. Atque de Directione Motus Ventorum hactenus. At

de Longitudine et tanquam itinerario ventorum videndum; licet de hoc ipso paulo ante, sub nomine Latitudinis ventorum, inquisitum videri possit. Nam et latitudo pro longitudine ab imperitis haberi possit, si majora spatia venti ex latere occupent quam in longitudine progrediantur.

14. Si verum sit Columbum ex oris Lusitaniæ per Ventos Statos ab occidente de Continente in America judicium fecisse, longo certe itinere possint commeare venti.

15. Si verum sit solutionem nivium circa Mare Glaciale et Scandiam excitare Aquilones in Italia et Græcia, &c. diebus canicularibus, longa certe sunt spatia.

16. Quanto citius in consecutione in qua ventus movet (exempli gratia, si sit Eurus) veniat tempestas ad locum aliquem ab oriente, quanto vero tardius ab occidente, nondum venit in observationem.

De Motu Ventorum in Progressu hactenus; videndum jam de Undulatione Ventorum.

17. Undulatio ventorum ad parva momenta fit; adeo ut centies in hora ad minus ventus (licet fortis) se suscitet et alternatim remittat; ex quo liquet inæqualem esse impetum ventorum. Nam nec flumina, licet rapida, nec currentes in mari, licet robusti, undulant, nisi accidente flatu ventorum; neque ipsa illa undulatio ventorum aliquid æqualitatis habet in se; nam instar pulsus manus, aliquando intercurrit, aliquando intermittit.

18. Undulatio aëris in eo differt ab undulatione aquarum, quod in aquis, postquam fluctus sublati fuerint in altum, sponte rursus decidant ad planum; ex quo fit ut (quicquid dicant poëtæ exaggerando tempestates, quod *undæ attollantur in cœlum, et descendant in Tartarum*) tamen descensus undarum non multum præcipitetur ultra planum et superficiem aquarum. At in undulatione aëris, ubi deest motus gravitatis, deprimitur et attollitur aër fere ex æquo.

De Undulatione hactenus: jam de Motu Conflictus inquirendum est

19. De Conflictu ventorum et compositis currentibus jam partim inquisitum est. Plane constat *ubiquetarios* esse ventos, præsertim leniores; id quod manifestum etiam ex hoc, quod pauci sunt dies aut horæ, in quibus non spirent auræ aliquæ lenes in locis liberis, idque satis inconstanter et varie. Nam venti qui non proveniunt ex fomitibus majoribus, vagabundi

sunt et volubiles, altero cum altero quasi ludente, modo impellente, modo fugiente.

20. Visum est nonnunquam in mari advenisse duos ventos simul ex contrariis partibus; id quod ex perturbatione superficiei aquæ ab utraque parte, atque tranquillitate aquæ in medio inter eos, facile erat conspicere; postquam autem concurrissent illi venti contrarii, alias secutam esse tranquillitatem in aqua undique, cum scilicet venti se ex æquo fregissent, alias continuatam esse perturbationem aquæ, cum scilicet fortior ventus prævaluisset.

21. Certum est in montibus Peruvianis sæpe accidere, ut venti eodem tempore super montes ex una parte spirent, in vallibus in contrarium.

22. Itidem certum apud nos, nubes in unam partem ferri, cum ventus a contraria parte flet hic in proximo.

23. Quin et illud certum, aliquando cerni nubes altiores supervolare nubes humiliores; atque ita ut in diversas aut etiam in contrarias partes abeant, tanquam currentibus adversis.

24. Itidem certum, quandoque in superiore aëre ventos nec distrahi nec promoveri, cum hic infra ad semi-milliare insano ferantur impetu.

25. Certum etiam e contra, esse aliquando tranquillitatem infra, cum superne nubes ferantur satis alacriter; sed id rarius est.

Phænomenon obliquum. Etiam in fluctibus, quandoque supernatans aqua, quandoque demersa, incitatior est; quinetiam fiunt (sed raro) varii currentes aquæ, quæ volvitur supra, et quæ labitur in imo.

26. Neque prorsus contemnenda illa testimonia Virgilii, cum naturalis philosophiæ non fuerit ipse omnino imperitus;

> Una Eurusque Notusque ruunt, creberque procellis
> Africus.

Et rursus;

> Omnia ventorum concurrere prælia vidi.

De Motibus Ventorum in natura rerum, inquisitum est; videndum de Motibus eorum in Machinis Humanis; ante omnia in velis navium.

Motus Ventorum in Velis Navium.

1. In navibus majoribus Britannicis [1] (eas enim ad exemplum delegimus) quatuor sunt mali, aliquando quinque; omnes in linea recta per medium navis ducta alteri post alteros erecti. Eos sic nominabimus:

2. *Malum principem*, qui in medio navis est; *malum proræ*; *malum puppis* (qui aliquando est geminus); et *malum rostri*.

3. Habent singuli mali plures portiones; quæ sustolli, et per certos nodos aut articulos figi, et similiter auferri possunt; alii tres, alii duas tantum.

4. Malus rostri stat ab inferiori nodo inclinatus versus mare, a superiori rectus; reliqui omnes mali stant recti.

5. His malis superimpendent Vela decem, et quando malus puppis geminatur, duodecim. Malus princeps et malus proræ tres habent ordines velorum. Eos sic nominabimus: *velum ab infra*, *velum a supra*, et *velum a summo*. Reliqui habent duos tantum, carentes velo a summo.

6. Vela extenduntur in transversum, juxta verticem cujusque nodi mali, per ligna quæ *antennas* vel virgas dicimus, quibus suprema velorum assuuntur, ima ligantur funibus ad angulos tantum; vela scilicet ab infra ad latera navis, vela a supra aut a summo ad antennas contiguas. Trahuntur etiam aut vertuntur iisdem funibus in alterutrum latus ad placitum.

7. Antenna sive virga cujusque mali in transversum porrigitur. Sed in malis puppis ex obliquo, altero fine ejus elevato, altero depresso; in cæteris in recto, ad similitudinem literæ *Tau*.

8. Vela ab infra, quatenus ad vela principis, proræ, et rostri, sunt figuræ quadrangularis, parallelogrammæ; vela a supra et a summo nonnihil acuminata, sive surgentia in arctum; at ex velis puppis, quod a supra, acuminatum; quod ab infra, triangulare.

9. In navi [2] quæ erat mille et centum amphorarum, atque

[1] See the woodcut at the front of this volume, representing the "Great Harry," a ship built in 1514 and burnt by accident in 1553 It is a reduced copy of an engraving by P. C. Canot (published in 1767), from a drawing by T. Allen, after an original by Hans Holbein. — *J. S.*

[2] Ships of 1200 tons were so rare in Bacon's time that it seems clear that he here refers either to the "Prince Royal," built in the year 1610, or to the "Trade's-increase," built, according to Stow, in 1609. See what is said of them in Charnock's *History of Marine Architecture*, vol. ii. pp. 197. and 203. The former was a man-of-war, the latter was built for the India trade. Stow makes the keel of the "Prince Royal" 114 feet in length, and the cross-beam 44 feet. He calls the burden 1400 tons; but other authorities, according to Charnock, make it 1200 only. She was built by Phineas Pett, of Emanuel College, Cambridge.

habebat in longitudine, in carina, pedes 112, in latitudine, in alveo, 40, velum ab infra mali principis continebat in altitudine pedes 42, in latitudine pedes 87.

10. Velum a supra ejusdem mali habebat in altitudine pedes 50; in latitudine pedes 84 ad basim, pedes 42 ad fastigium.

11. Velum a summo in altitudine pedes 27; in latitudine pedes 42 ad basim, 21 ad fastigium.

12. In malo proræ, velum ab infra habebat in latitudine pedes 40 cum dimidio; in latitudine pedes 72.

13. Velum a supra in altitudine pedes 46 cum dimidio; in latitudine pedes 69 ad basim, 36 ad fastigium.

14. Velum a summo in altitudine pedes 24; in latitudine pedes 36 ad basim, 18 ad fastigium.

15. In malo puppis, velum ab infra habebat in altitudine, a parte antennæ elevata, pedes 51; in latitudine, qua jungitur antennæ, pedes 72, reliquo desinente in acutum.

16. Velum a supra, in altitudine pedes 30; in latitudine pedes 57 ad basim, 30 ad cacumen.

17. Si geminetur malus puppis, in posteriore vela minuuntur ab anteriore ad partem circiter quintam.

18. In malo rostri, velum ab infra habebat in altitudine pedes 28 cum dimidio; in latitudine pedes 60.

19. Velum a supra in altitudine pedes 25 cum dimidio; in latitudine pedes 60 ad basim, 30 ad fastigium.

20. Variant proportiones malorum et velorum, non tantum pro magnitudine navium, verum etiam pro variis earum usibus, ad quos ædificantur; ad pugnam, ad mercaturam, ad velocitatem, et cætera. Verum nullo modo convenit proportio dimensionis velorum ad numerum amphorarum, cum navis quingentarum amphorarum, aut circiter, portet velum ab infra principis mali paucos pedes minus undique, quam illa altera quæ erat duplicis magnitudinis. Unde fit ut minores naves longe præstent celeritate majoribus, non tantum propter levitatem, sed etiam propter amplitudinem velorum, habito respectu ad corpus navis; nam proportionem illam continuare in navibus majoribus nimis vasta res esset et inhabilis.

21. Cum singula vela per summa extendantur, per ima ligentur tantum ad angulos, ventus necessario facit vela intumescere, præsertim versus ima, ubi sunt laxiora.

22. Longe autem major est tumor veli in velis ab infra, quam in cæteris; quia non solum parallelogramma sunt, cætera

acuminata; verum etiam quia latitudo antennæ tanto excedit latitudinem laterum navis, ad quæ alligantur; unde necesse est, propter laxitatem, magnum dari receptum ventis; adeo ut in illa magna, quam exempli loco sumpsimus, navi, tumor in vento recto possit esse ad 9 aut 10 pedes introrsum.

23. Fit etiam ob eandem causam, quod vela omnia, a vento tumefacta, ad imum colligant se in arcus, adeo ut multum venti præterlabi necesse sit; in tantum ut in illa quam diximus navi arcus ille ad staturam hominis accedat.

24. At in velo puppis illo triangulari, necesse est ut minor sit tumor, quam in quadrangulari; tum propter figuram minus capacem, tum quia in quadrangulari tria latera laxa sunt, in triangulari duo tantum; unde sequitur quod ventus excipiatur magis rigide.

25. Motus ventorum in velis, quo magis accedat ad rostrum navis, est fortior, et promovet magis; tum quia fit in loco ubi undæ, propter acumen proræ, facillime secantur; tum maxime quia motus a prora trahit navem, motus a puppi trudit.

26. Motus ventorum in velis superiorum ordinum promovet magis, quam in velis ordinis inferioris; quia motus violentus maxime efficax est ubi plurimum removetur a resistentia; ut in vectibus et velis molendinorum. Sed periculum est demersionis aut eversionis navis; itaque et acuminata sunt illa, ne ventos nimios excipiant, et in usu præcipue cum spirent venti leniores.

27. Cum vela collocentur in recta linea, altera post altera, necesse est ut quæ posterius constituantur, suffurentur ventum a prioribus, cum ventus flet recta; itaque si omnia simul fuerint erecta, tamen vis venti fere tantum locum habet in velis mali principis, cum parvo auxilio veli ab infra in malo rostri.

28. Fœlicissima et commodissima dispositio velorum in vento recto ea est, ut vela duo inferiora mali proræ erigantur; ibi enim (ut dictum est) motus est maxime efficax; erigatur etiam velum a supra mali principis; relinquitur enim spatium tantum subter, ut ventus sufficere possit velis prædictis proræ, absque suffuratione notabili.

29. Propter illam, quam diximus, suffurationem ventorum, celerior est navigatio cum vento laterali, quam cum recto. Laterali enim flante, omnia vela in opere poni possunt; quia latera sibi invicem obvertunt, nec altera altera impediunt, neque fit furtum.

30. Etiam flante vento laterali, vela rigidius in adversum venti extenduntur; quod ventum comprimit nonnihil, et immittit in eam partem ubi flare debet, unde nonnihil fortitudinis acquirit. Ventus autem maxime propitius est, qui flat in quadra inter rectum et lateralem.

31. Velum ab infra mali rostri vix unquam posset esse inutile; neque enim patitur furtum, quando colligat ventum qui flat undequaque circa latera navis et subter vela cætera.

32. Spectatur in motu ventorum in navibus tum impulsio tum directio. At directio illa quæ fit per clavum non multum pertinet ad inquisitionem præsentem, nisi quatenus habeat connexionem cum motu ventorum in velis.

Connexio. Ut motus impulsionis in vigore est in prora, ita motus directionis in puppi; itaque ad eum velum ab infra mali puppis est maximi momenti, et quasi copiam præbet auxiliarem clavo.

33. Cum pyxis nautica in plagas 32 distribuatur, adeo ut semicirculi ejus sint plagæ sedecim, potest fieri navigatio progressiva (non angulata, quæ fieri solet in ventis plane contrariis) etiamsi ex illis sedecim partibus decem fuerint adversæ, et sex tantum favorabiles[1]; at ea navigatio multum pendet ex velo ab infra mali puppis; cum enim venti partes contrariæ itineri, quia sunt præpotentes et clavo solo regi non possunt, alia vela obversuræ forent, una cum navi ipsa, in partem contrariam itineris, illud velum rigide extensum, ex opposito favens clavo et ejus motum fortificans, vertit et quasi circumfert proram in viam itineris.

34. Omnis ventus in velis nonnihil aggravat et deprimit navem; tantoque magis quo flaverit magis desuper. Itaque tempestatibus majoribus primo devolvunt antennas et auferunt vela superiora, deinde, si opus fuerit, omnia; etiam malos ipsos incidunt; quin et projiciunt onera mercium, tormentorum, &c. ut allevent navem, ad supernatandum et præstandum obsequia undis.

35. Potest fieri per motum istum ventorum in velis navium (si ventus fuerit alacris et secundus) progressus in itinere 120 milliarium Italicorum intra spatium 24 horarum; idque in navi

[1] It is commonly said that a square-rigged vessel will lie within six points of the wind, which is what Bacon intends to express; so that there is no change in this respect since his time.

mercatoria; sunt enim naves quædam nunciæ, quæ ad officium celeritatis apposite extructæ sunt (quas *caruvellas* vocant) quæ etiam majora spatia vincere possunt. At cum venti plane contrarii sint, remedio ad iter promovendum utuntur hoc ultimo et pusillo; ut procedant lateraliter, prout ventus permittit, extra viam itineris, deinde flectant se versus iter, atque angulares istos progressus repetant; ex quo genere progressus (quod est minus quam ipsum serpere, nam serpentes sinuant, at illi angulos faciunt) poterint fortasse intra 24 horas vincere milliaria 15.

Observationes Majores.

1. Motus iste ventorum in velis navium habet impulsionis suæ tria præcipua capita et fontes, unde fluit; unde etiam præcepta sumi possint ad eum augendum et fortificandum.

2. Primus fons est ex *Quanto venti* qui excipitur. Nam nemini dubium esse possit, quin plus venti magis conferat quam minus. Itaque Quantum ipsum venti procurandum diligenter. Id fiet, si instar patrumfamilias prudentiorum, et frugi simus et a furto caveamus. Quare, quantum fieri potest, nil venti disperdatur aut effundatur; nil etiam surripiatur.

3. Ventus aut supra latera navium flat, aut infra usque ad aream maris. Atque ut homines providi solent etiam circa minima quæque magis curare (quia majora nemo non curare potest), ita de istis inferioribus ventis (qui proculdubio non tantum possunt quantum superiores) primo videndum.

4. Ad ventos qui circum latera navium et subter vela ipsarum potissimum flant, plane est officium veli ab infra mali rostri, quæ inclinata est et depressa, ut excipiantur; ne fiat dispendium et jactura venti. Idque et per se prodest, et ventis qui reliquis velis ministrant nil obest. Circa hoc non video quid ulterius per diligentiam humanam fieri possit, nisi forte etiam ex medio navis similia vela humilia adhibeantur, instar pinnarum aut alarum, ex utroque latere gemina, cum ventus est rectus.

5. At quod ad cavendum de furto attinet, quod fit cum vela posteriora ventum ab anterioribus surripiant in vento recto (nam in laterali omnia vela cooperantur), non video quid addi possit diligentiæ humanæ; nisi forte ut, flante

vento recto, fiat scala quædam velorum, ut posteriora vela a malo puppis sint humillima, media a malo principis mediocria, anteriora a malo proræ celsissima; ut alterum velum alterum non impediat, sed potius adjuvet, et ventum tradat et transmittat. Atque de primo fonte impulsionis hæc observata sint.

6. Secundus fons impulsionis est ex modo *percussionis veli per ventum;* quæ, si propter ventum contractum sit acuta et rapida, movebit magis; si obtusa et languida, minus.

7. Quod ad hoc attinet, plurimum interest ut vela mediocrem extensionem et tumorem recipiant; nam si extendantur rigide, instar parietis ventum repercutiunt; si laxe, debilis fit impulsio.

8. Circa hoc bene se expedivit in aliquibus industria humana, licet magis ex casu quam ex judicio. Nam in vento laterali, contrahunt partem veli quæ vento opponitur, quantum possunt; atque hoc modo ventum immittunt in eam partem qua flare debet. Atque hoc agunt, et volunt. Sed interim hoc sequitur (quod fortasse non vident), ut ventus sit contractior, et reddat percussionem magis acutam.

9. Quid addi possit industriæ humanæ in hac parte, non video; nisi mutetur figura in velis, et fiant aliqua vela non tumentia in rotundo, sed instar calcaris aut triianguli cum malo aut ligno in illo angulo verticis, ut et ventum magis contrahant in acutum, et secent aërem externum potentius. Ille autem angulus (ut arbitramur) non debet esse omnino acutus, sed tanquam triangulus curtatus, ut habeat latitudinem. Neque etiam novimus quid profuturum foret, si fiat tanquam velum in velo; hoc est, si in medio veli alicujus majoris sit bursa quædam, non omnino laxa ex carbaso, sed cum costis ex lignis, quæ ventum in medio veli excipiat et cogat in acutum.

10. Tertius fons impulsionis est ex loco ubi fit percussio; isque duplex. Nam ex anteriore parte navis facilior et fortior est impulsio quam ex posteriore; et ex superiore parte mali et veli, quam ab inferiore.

11. Neque hoc ignorasse visa est industria humana, cum et flante vento recto plurimam in velis mali proræ spem

ponant; et in malaciis et tranquillitatibus vela a summo erigere non negligant. Neque nobis in præsentia occurrit, quid humanæ ex hac parte industriæ addi possit, nisi forte quoad primum, ut constituantur duo aut tres mali in prora (medius rectus, reliqui inclinati) quorum vela propendeant; et quoad secundum, ut amplientur vela proræ in summo, et sint minus quam solent esse acuminata. Sed in utroque cavendum incommodo periculi ex nimia depressione navis.

Motus Ventorum in aliis Machinis Humanis.

1. Motus Molendinorum ad ventum nihil habet subtilitatis, et nihilominus non bene demonstrari et explicari solet. Vela constituuntur recta in oppositum venti flantis. Prostat autem in ventum unum latus veli, alterum latus paulatim flectit se et subducit a vento. Conversio autem sive consecutio motus fit semper a latere inferiore, hoc est, eo quod remotius est a vento. At ventus superfundens se in adversum machinæ, a quatuor velis arctatur, et in quatuor intervallis viam suam inire cogitur. Eam compressionem non bene tolerat ventus; itaque necesse est ut tanquam cubito percutiat latera velorum et proinde vertat, quemadmodum ludicra vertibula digito impelli et verti solent.[1]

2. Quod si vela ex æquo expansa essent, dubia res esset ex qua parte foret inclinatio, ut in casu baculi. Cum autem proximum latus, quod occurrit vento, impetum ejus dejiciat in latus inferius, atque illinc in spatia; cumque latus inferius ventum excipiat, tanquam palma manus, aut instar veli scaphæ; fit protinus conversio ab ea parte. Notandum autem est, originem motus esse non a prima impulsione quæ fit in fronte; sed a laterali impulsione post compressionem.

3. Probationes quasdam et experimenta circa hoc, pro augendo hoc motu, fecimus, tum ad pignus causæ recte inventæ tum ad usum; imitamenta hujus motus effingentes in velis ex chartis, et vento ex follibus. Igitur addidimus lateri veli inferiori plicam inversam a vento, ut haberet ventus, lateralis jam factus, amplius quiddam quod percuteret; nec profuit; plica illa non tam percussionem venti adjuvante, quam sectionem aëris in consequentia impediente. Locavimus post vela ad nonnullam distantiam obstacula, in latitudinem diametri omnium

[1] This explanation is of course altogether wrong.

velorum, ut ventus magis compressus fortius percuteret; at hoc obfuit potius; repercussione motum primarium hebetante. At vela fecimus latiora in duplum, ut ventus arctaretur magis, et fieret percussio lateralis fortior. Hoc tandem magnopere successit; ut et longe mitiore flatu fieret conversio, et longe magis perniciter volveretur.

Mandatum. Fortasse hoc augmentum motus commodius fiet per octo vela, quam per vela quatuor, latitudine duplicata; nisi forte nimia moles aggravaverit motum. De hoc fiat experimentum.

Mandatum. Etiam longitudo velorum facit ad motum. Nam in rotationibus, levis violentia versus circumferentiam æquiparatur longe majori versus centrum. Sed tamen hoc conjungitur incommodum, quod quo longiora sunt vela, eo plus distant in summo, et minus arctatur ventus. Res non male fortasse se habeat, si vela sint paulo longiora, sed crescentia in latum circa summitatem, ut palma remi; sed de hoc nobis compertum non est.

Monitum. In his experimentis, si ponantur in usu ad molendina, robori totius machinæ, præcipue fundamentis ejus, subveniendum. Nam quanto magis arctatur ventus, tanto magis (licet motum velorum incitet) tamen machinam ipsam concutit.

4. Traditur alicubi esse rhedas moventes ad ventum; de hoc diligentius inquiratur.[1]

Mandatum. Rhedæ moventes ad ventum non poterunt esse operæ pretium, nisi in locis apertis et planitiebus. Præterea quid fiet, si decubuerit ventus? Magis sobria esset cogitatio de facilitando motu curruum et plaustrorum per vela mobilia, ut equi vel boves minoribus viribus ea traherent, quam de creando motu per ventum solum.

[1] Bacon had probably heard of the chariots with sails constructed by Stevinus. It is said that one of these was still in existence at Steveninque in 1802, and that on the occasion of the marriage of the Prince of Brunswick it was brought out; but it seems to have been unmanageable in consequence of the inexperience of the conductor. See *Mémoire sur la Vie et les Travaux de Stevin*, par Steichen, p. 198. Compare Milton:

"In Sericana, where Chineses drive
With wind and sail their cany waggons light."

Stevinus's chariot was constructed about the year 1600, and, according to Grotius, went three times as fast as a ship at sea. He speaks of a trial where it went fourteen leagues in two hours. (See Steichen, p. 164.) Nothing is known of the details of the construction of this chariot. Milton had probably read what Gonzales de Mendoza says of the Chinese sailing chariots. Mendoza's statement does not seem to be confirmed by later and better informed travellers. Vide Mendoza's *Histoire de la Chine*, f. 16. I quote from the French translation of 1600.

Prognostica Ventorum.[1]

Ad Art. 32. *Connexio.* Divinatio quo magis pollui solet vanitate et superstitione, eo purior pars ejus magis recipienda et colenda. Naturalis vero divinatio aliquando certior est, aliquando magis in lubrico, prout subjectum se habet, circa quod versatur. Quod si fuerit naturæ constantis et regularis, certam efficit prædictionem; si variæ, et compositæ tanquam ex natura et casu, fallacem. Attamen etiam in subjecto vario, si diligenter canonizetur, tenebit prædictio ut plurimum; temporis forte momenta non assequetur, a re non multum errabit. Quinetiam quoad tempora eventus et complementi, nonnullæ prædictiones satis certo collimabunt; eæ videlicet quæ sumuntur non a causis, verum ab ipsa re jam inchoata, sed citius se prodente in materia proclivi et aptius disposita, quam in alia; ut in topicis circa hunc 32 articulum superius diximus. Prognostica igitur Ventorum jam proponemus, miscentes nonnihil necessario de Prognosticis Pluviarum et Serenitatis, quæ bene distrahi non poterant; sed justam de illis inquisitionem propriis titulis remittentes.

1. Sol si oriens cernatur concavus, dabit eo ipso die ventos aut imbres; si appareat tanquam leviter excavatus, ventos; si cavus in profundo, imbres.

2. Si sol oriatur pallidus et (ut nos loquimur) aqueus, denotat pluviam; si occidat pallidus, ventum.

3. Si corpus ipsum solis in occasu cernatur tanquam sanguineum, præmonstrat magnos ventos in plures dies.

4. Si in exortu solis radii ejus spectantur rutili, non flavi, denotat pluvias potius quam ventos; idemque, si tales appareant in occasu.

5. Si in ortu aut occasu solis spectantur radii ejus tanquam contracti aut curtati, neque eminent illustres, licet nubes absint, significat imbres potius quam ventos.

6. Si ante ortum solis ostendent se radii præcursores, et ventum denotat et imbres.

7. Si in exortu solis porrigat sol radios e nubibus, medio solis manente cooperto nubibus, significabit pluviam; maxime

[1] Almost all these prognostics are taken, with more or less modification, from the eighteenth book of Pliny, §§ 78—90.

si erumpant radii illi deorsum, ut sol cernatur tanquam barbatus. Quod si radii erumpant e medio, aut sparsim, orbe exteriore cooperto nubibus, magnas dabit tempestates et ventorum et imbrium.

8. Si sol oriens cingitur circulo, a qua parte is circulus se aperuerit, expectetur ventus; sin totus circulus æqualiter defluxerit, dabit serenitatem.

9. Si sub occasum solis appareat circa eum circulus candidus, levem denotat tempestatem eadem nocte; si ater aut subfuscus, ventum magnum in diem sequentem.

10. Si nubes rubescant exoriente sole, prædicunt ventum; si occidente, serenum in posterum.

11. Si sub exortum solis globabunt se nubes prope solem, denunciant eodem die tempestatem asperam; quod si ab ortu repellantur et ad occasum abibunt, serenitatem.

12. Si in exortu solis dispergantur nubes a lateribus solis, aliæ petentes Austrum, aliæ Septentrionem, licet sit cœlum serenum circa ipsum solem, præmonstrat ventos.

13. Si sol sub nube condatur occidens, pluviam denotat in posterum diem; quod si plane pluet occidente sole, ventos potius; sin nubes videantur quasi trahi versus solem, et ventos et tempestatem.

14. Si nubes, exoriente sole, videantur non ambire solem, sed incumbere ei desuper, tanquam eclipsim facturæ, portendunt ventos, ex ea parte orituros qua illæ nubes inclinaverint. Quod si hoc faciant meridie, et venti fient et imbres.

15. Si nubes solem circuncluserint, quanto minus luminis relinquetur et magis pusillus apparebit orbis solis, tanto turbidior erit tempestas. Si vero duplex aut triplex orbis erit, ut appareant tanquam duo aut tres soles, tanto erit tempestas atrocior per plures dies.

16. Novilunia dispositionum aëris significativa sunt; sed magis adhuc ortus quartus, tanquam novilunium confirmatum. Plenilunia autem ipsa præsagiunt magis, quam dies aliqui ab ipsis.

17. Diuturna observatione, *quinta lunæ* suspecta est nautis, ob tempestates.

18. Si luna a novilunio ante diem quartum non apparuerit, turbidum aërem per totum mensem prædicit.

19. Si luna nascens, aut intra primos dies, cornu habuerit inferius magis obscurum aut fuscum, aut quovis modo non

purum, dies turbidos et tempestates dabit ante plenilunium; si circa medium fuerit decolor, circa ipsum plenilunium sequentur tempestates; si cornu superius hoc patiatur, circa lunam decrescentem.

20. Si ortu in quarto pura ibit luna per cœlum, nec cornibus obtusis, neque prorsus jacens, neque prorsus recta, sed mediocris, serenitatem promittit majore ex parte usque ad novilunium.

21. Si in ortu illo rubicunda fuerit, ventos portendit; si rubiginosa aut obatra, pluvias; sed nil horum significat ultra plenilunium.

22. Recta luna semper fere minax est et infesta, potissimum autem denunciat ventos; at si appareat cornibus obtusis et curtatis, imbres potius.

23. Si alterum cornu lunæ magis acuminatum fuerit et rigidum, altero magis obtuso, ventos potius significat: si utrunque pluviam.

24. Si circulus aut *halo* circa lunam appareat, pluviam potius significat quam ventos; nisi stet recta luna intra eum circulum, tum vero utrunque.

25. Circuli circa lunam ventos semper denotant ex parte qua ruperint; etiam splendor illustris circuli in aliqua parte, ventos ex ea parte qua splendet.

26. Circuli circa lunam, si fuerint duplices aut triplices, præmonstrant horridas et asperas tempestates; at multo magis, si illi circuli non fuerint integri, sed maculosi et interstincti.

27. Plenilunia, quoad colores et halones, eadem forte denotant, quæ ortus quartus; sed magis præsentia, nec tam procrastinata.

28. Plenilunia solent esse magis serena quam cæteræ ætates lunæ; sed eadem, hieme, quandoque intensiora dant frigora.

29. Luna sub occasum solis ampliata, et tamen luminosa, nec subfusca, serenitatem portat in plures dies.

30. Eclipses lunæ quasi semper comitantur venti; solis, serenitas; pluviæ raro alterutrum.

31. A conjunctionibus reliquis planetarum, præter solem, expectabis ventos, et ante et post; a conjunctionibus cum sole, serenitatem.

32. In exortu Pleiadum et Hyadum sequuntur imbres et pluviæ, sed tranquillæ; in exortu Orionis et Arcturi, tempestates.

33. Stellæ (ut loquimur) discurrentes et sagittantes protinus ventos indicant ex ea parte unde vibrantur. Quod si ex variis aut etiam contrariis partibus volitent, magnas tempestates et ventorum et imbrium.

34. Cum non conspiciantur stellæ minusculæ, quales sunt quas vocant *Asellos*, idque fit ubique per totum cœlum, magnas præmonstrat tempestates et imbres intra aliquot dies; quod si alicubi stellæ minutæ obscurentur, alicubi sint claræ, ventos tantum, sed citius.

35. Cœlum æqualiter splendens in noviluniis, aut ortu quarto, serenitatem dabit per plures dies; æqualiter obscurum, imbres; inæqualiter, ventos, ab ea parte qua cernitur obscuratio. Quod si subito fiat obscuratio sine nube aut caligine, quæ fulgorem stellarum perstringat, graves et asperæ instant tempestates.

36. Si planetarum aut stellarum majorum aliquam incluserit circulus integer, imbres prædicit; si fractus, ventos ad eas partes ubi circulus deficit.

37. Cum tonat vehementius quam fulgurat, ventos dabit magnos; sin crebro inter tonandum fulserit, imbres confertos et grandibus guttis.

38. Tonitrua matutina ventos significant; meridiana imbres.

39. Tonitrua mugientia, et veluti transeuntia, ventos significant; at quæ inæquales habent fragores et acutos, procellas, tam ventorum quam imbrium.

40. Cum cœlo sereno fulguraverit, non longe absunt venti et imbres ab ea parte qua fulgurat; quod si ex diversis partibus cœli fulguraverit, sequentur atroces et horridæ tempestates.

41. Si fulguraverit a plagis cœli gelidioribus, Septentrione et Aquilone, sequentur grandines: si a tepidioribus, Austro et Zephyro, imbres cum cœlo æstuoso.

42. Magni fervores post solstitium æstivale desinunt plerunque in tonitru et fulgura; quæ si non sequantur, desinunt in ventos et pluvias per plures dies.

43. Globus flammæ, quem *Castorem* vocabant antiqui, qui cernitur navigantibus in mari, si fuerit unicus, atrocem tempestatem prænunciat (*Castor* scilicet est frater intermortuus), at multo magis, si non hæserit malo, sed volvatur aut saltet. Quod si fuerint gemini (præsente scilicet *Polluce* fratre vivo), idque tempestate adulta, salutare signum habetur. Sin fuerint tres (superveniente scilicet *Helena*, peste rerum) magis dira incumbet tempestas. Videtur sane unicus, crudam significare

materiam tempestatis; duplex, quasi coctam et maturam; triplex vel multiplex, copiam ægre dissipabilem.[1]

44. Si conspiciantur nubes ferri incitatius cœlo sereno, expectentur venti ab ea parte a qua feruntur nubes. Quod si globabuntur et glomerabunt simul, cum sol appropinquaverit ad eam partem in qua globantur, incipient discuti; quod si discutientur magis versus Boream, significat ventum; si versus Austrum, pluvias.

45. Si occidente sole nubes orientur atræ aut fuscæ, imbrem significat; si adversus solem, in Oriente scilicet, eadem nocte; si juxta solem ab Occidente, in posterum diem, cum ventis.

46. Liquidatio sive disserenatio cœli nubili, incipiens in contrarium venti qui flat, serenitatem significat; sed a parte venti, nihil indicat, sed incerta res est.

47. Conspiciuntur quandoque plures veluti cameræ aut contignationes nubium, altera super alteras (ut aliquando quinque simul se vidisse, et notasse affirmet Gilbertus[2]), et semper atriores sunt infimæ, licet quandoque secus appareat, quia candidiores visum magis lacessunt. Duplex contignatio, si sit spissior, pluvias denotat instantes (præsertim si nubes inferior cernatur quasi gravida); plures contignationes perendinant pluvias.

48. Nubes, si ut vellera lanæ spargantur, hinc inde, tempestates denotant; quod si instar squamarum aut testarum altera alteri incumbat, siccitatem et serenitatem.

49. Nubes plumatæ et similes ramis palmæ, aut floribus iridis, imbres protinus, non ita multo post, denunciant.

50. Cum montes et colles conspiciantur veluti pileati, incumbentibus in illis nubibus, eosque circumplectentibus, tempestates præmonstrant imminentes.

51. Nubes electrinæ et aureæ ante occasum solis, et tanquam cum fimbriis deauratis, postquam sol magis condi cœperit, serenitates præmonstrant.

52. Nubes luteæ, et tanquam cœnosæ, significant imbrem cum vento instare.

53. Nubecula aliqua non ante visa subito se monstrans, cœlo circum sereno, præsertim ab occidente aut circa meridiem, tempestatem indicat ingruentem.

[1] Pliny, ii. [37.]; and see Ideler, Meteorol. Vet. p. 164.

[2] "Vidi egomet, indicantibus nubium globis, quinque simul dispares ventos altitudine in aëre et positione ab horizonte."—*Gilbert, Physiol.* iv. 1.

54. Nebulæ et caligines ascendentes et sursum se recipientes, pluvias; et si subito hoc fiat, ut tanquam sorbeantur, ventos prædicunt; at cadentes et in vallibus residentes, serenitatem.

55. Nube gravida candicante, quam vocant antiqui *tempestatem albam*, sequitur, æstate, grando minutus instar confituræ; hieme, nix.

56. Autumnus serenus ventosam hiemem præmonstrat; ventosa[1] hiems, ver pluviosum; ver pluviosum, æstatem serenam; serena æstas, autumnum ventosum. Ita ut annus (ut proverbio dicitur) sibi debitor raro sit; neque eadem series tempestatum redeat per duos annos simul.

57. Ignes in focis pallidiores solito, atque intra se murmurantes, tempestates nunciant. Quod si flamma flexuose volitet et sinuet, ventum præcipue; at fungi sive tuberes in lucernis, pluvias potius.

58. Carbones clarius perlucentes, ventum significant; etiam cum favillas ex se citius discutiunt et deponunt.

59. Mare cum conspicitur in portu tranquillum in superficie, et nihilominus intra se murmuraverit, licet non intumuerit, ventum prædicit.

60. Littora in tranquillo resonantia, marisque ipsius sonitus cum plangore aut quadam echo clarius et longius solito auditus, ventos prænunciant.

61. Si in tranquillo et plana superficie maris conspiciantur spumæ hinc inde, aut coronæ albæ, aut aquarum bullæ, ventos prædicunt; et si hæc signa fuerint insigniora, asperas tempestates.

62. In mari fluctibus agitato si appareant spumæ coruscantes (quas *pulmones marinos* vocant), prænunciant duraturam tempestatem in plures dies.

63. Si mare silentio intumescat et intra portum altius solito insurgat, aut æstus ad littora celerius solito accedat, ventos prænunciat.

64. Sonitus a montibus, nemorumque murmur increbrescens, atque fragor etiam nonnullus in campestribus, ventos portendit. Cœli quoque murmur prodigiosum, absque tonitru, ad ventos maxime spectat.

65. Folia et paleæ ludentes, sine aura quæ sentiatur, et lanu-

[1] *Ventosus* in the original. —*J. S.*

gines plantarum volitantes, plumæque in aquis innatantes et colludentes, ventos adesse nunciant.

66. Aves aquaticæ concursantes et gregatim volantes, mergique præcipue et fulicæ a mari aut stagnis fugientes, et ad littora aut ripas properantes, præsertim cum clangore, et ludentes in sicco, ventos prænunciant, maxime si hoc faciant mane.

67. At terrestres volucres contra, aquam petentes eamque alis percutientes et clangores dantes et se perfundentes, ac præcipue cornix, tempestates portendunt.

68. Mergi anatesque ante ventum pennas rostro purgant; at anseres clangore suo importuno pluviam invocant.

69. Ardea petens excelsa, adeo ut nubem quandoque humilem supervolare conspiciatur, ventum significat. At milvi contra in sublimi volantes, serenitatem.

70. Corvi singultu quodam latrantes, si continuabunt, ventos denotant; si vero carptim vocem resorbebunt, aut per intervalla longiora crocitabunt, imbres.

71. Noctua garrula putabatur ab antiquis mutationem tempestatis præmonstrare; si in sereno, imbres; si in nubilo, serenitatem; at apud nos, noctua clare et libenter ululans serenitates plerunque indicat, præcipue hieme.

72. Aves in arboribus habitantes, si in nidos suos sedulo fugitent et a pabulo citius recedant, tempestates præmonstrant; ardea vero in arena stans tristis, aut corvus spatians, imbres tantum.

73. Delphini tranquillo mari lascivientes flatum existimantur prædicere, ex qua veniunt parte; at turbato ludentes et aquam spargentes, contra, serenitatem. At plerique piscium in summo natantes, aut quandoque exilientes, pluviam significant.

74. Ingruente vento, sues ita terrentur et turbantur et incomposite agunt, ut rustici dicant illud solum animal videre ventum, specie scilicet horrendum.

75. Paulo ante ventum araneæ sedulo laborant et nent, ac si provide præoccuparent, quia vento flante nere nequeunt.[1]

76. Ante pluviam, campanarum sonitus auditur magis ex longinquo; at ante ventum, auditur magis inæqualiter, accedens et recedens, quemadmodum fit vento manifesto flante.

[1] Pliny, xi.

77. Trifolium inhorrescere, et folia contra tempestatem subrigere, pro certo ponit Plinius.

78. Idem ait, vasa in quibus esculenta reponuntur quandoque sudorem in repositoriis relinquere, idque diras tempestates prænunciare.

Monitum. Cum pluvia et venti habeant materiam fere communem; cumque ventum semper præcedat nonnulla condensatio aëris, ex aëre noviter facto intra veterem recepto, ut ex plangoribus littorum, et excelso volatu ardeæ, et aliis patet; cumque pluviam similiter præcedat aëris condensatio (sed aër in pluvia postea contrahitur magis, in ventis contra excrescit), necesse est ut pluviæ habeant complura prognostica cum ventis communia. De iis consule Prognostica Pluviarum, sub titulo suo.

Imitamenta Ventorum.

Ad Art. 33 *Connexio.* Si animum homines inducere possent, ut contemplationes suas in subjecto sibi proposito non nimium figerent, et cætera tanquam *parerga* rejicerent; nec circa ipsum subjectum in infinitum et plerunque inutiliter subtilizarent; haudquaquam talis, qualis solet, occuparet ipsos stupor, sed transferendo cogitationes suas et discurrendo, plurima invenirent in longinquo quæ prope latent. Itaque ut in Jure Civili, ita in Jure Naturæ, procedendum animo sagaci ad similia et conformia.

1. Folles apud homines *Æoli utres* sunt; unde ventum quis promere possit, pro modulo nostro. Etiam interstitia et fauces montium, et ædificiorum anfractus, non alia sunt quam folles majores. In usu autem sunt folles præcipue aut ad excitationem flammarum, aut ad organa musica. Follium autem ratio est, ut sugant aërem propter rationem *vacui* (ut loquuntur), et emittant per compressionem.

2. Etiam flabellis utimur manualibus ad faciendum ventum et refrigeria, impellendo solummodo aërem leniter.

3. De cœnaculorum æstivorum refrigeriis quædam posuimus in responso ad artic. 9. Possunt inveniri alii modi magis accurati, præsertim si, follium modo, alicubi attrahatur aër, alicubi emittatur. Sed ea quæ jam in usu sunt ad simplicem compressionem tantum referuntur.

4. Flatus in microcosmo et animalibus, cum ventis in mundo majore optime conveniunt; nam et ex humore gignuntur et cum humore alternant, ut faciunt venti et pluviæ; et a calore fortiore dissipantur et perspirant. Ab illis autem transferenda est certe ea observatio ad ventos; quod scilicet gignantur flatus ex materia quæ dat vaporem tenacem, nec facile resolubilem; ut fabæ, et legumina, et fructus; quod etiam eodem modo se habet in ventis majoribus.

5. In destillatione vitrioli et aliorum fossilium, quæ sunt magis flatuosa, opus est receptaculis valde capacibus et amplis, alioqui effringentur.

6. Ventus factus ex nitro commisto in pulvere pyrio, erumpens et inflans flammam, ventos in universo (exceptis fulminosis) non tantum imitatur, sed exuperat.

7. Hujus autem vires premuntur in machinis humanis, ut in bombardis, et cuniculis, et domibus pulvervariis incensis; utrum autem, si in aëre aperto magna pulveris pyrii moles incensa esset, ventum ex aëris commotione etiam ad plures horas excitatura esset, nondum venit in experimentum.

8. Latet spiritus flatuosus et expansivus in argento vivo, adeo ut pulverem pyrium (ut quidam volunt) imitetur, et parum ex eo, pulveri pyrio admistum, eum reddat fortiorem. Etiam de auro loquuntur chymistæ, quod periculose, et fere tonitrui modo, in quibusdam præparationibus erumpat; sed de his mihi non compertum est.[1]

Observatio Major.

Motus ventorum tanquam in speculo spectatur in motibus aquarum quoad plurima.[2]

Venti magni sunt inundationes aëris, quales conspiciuntur inundationes aquarum; utræque ex aucto Quanto. Quemadmodum aquæ aut descendunt ex alto aut emanant e terra; ita et ventorum nonnulli sunt dejecti, nonnulli exurgunt. Quemadmodum nonnunquam intra amnes sunt contrarii motus; unus fluxus maris, alter cursus amnis; et nihilominus unicus efficitur motus, prævalente fluxu maris; ita et

[1] See Beckmann, *Hist. of Invent.* [iii. 128.], for an account of the discovery of fulminating gold.

[2] We find this analogy in Aristotle. See the *Problems*, xxvi. 38., and compare the *Meteorol.* i. 13.

flantibus ventis contrariis, major in ordinem redigit minorem. Quemadmodum in currentibus maris et quorundam amnium aliquando evenit, ut gurges in summitate aquæ in contrarium vergat gurgiti in profundo; ita et in aëre, flantibus simul contrariis ventis, alter alterum supervolat. Quemadmodum sunt cataractæ pluviarum in spatio angusto; similiter et turbines ventorum. Quemadmodum aquæ, utcunque progrediantur, tamen si perturbatæ fuerint, interim undulant, modo ascendentes et cumulatæ, modo descendentes et sulcatæ; similiter faciunt et venti, nisi quod absit motus gravitatis. Sunt et aliæ similitudines, quæ ex iis quæ inquisita sunt notari possunt.

Canones Mobiles de Ventis.

Connexio. Canones aut particulares sunt aut generales; utrique mobiles apud nos. Nil enim adhuc pronunciamus. At particulares ex singulis fere articulis possunt decerpi aut exproni; generales, eosque paucos, ipsi jam excerpemus et subjungemus.

1. Ventus non est aliud quippiam ab aëre moto, sed ipse *aër motus;* aut per *impulsionem simplicem,* aut per *immistionem vaporum.*

2. Venti per impulsionem aëris simplicem fiunt quatuor modis; aut per motum aëris naturalem; aut per expansionem aëris in viis solis; aut per receptionem aëris ex frigore subitaneo; aut per compressionem aëris per corpora externa.

> Possit esse et quintus modus, per agitationem et concussionem aëris ab astris; sed sileant paulisper hujusmodi res, aut audiantur parca fide.

3. Ventorum qui fiunt per immistionem vaporum præcipua causa est superoneratio aëris per aërem noviter factum ex vaporibus; unde moles aëris excrescit, et nova spatia quærit.

4. Quantum non magnum aëris superadditi magnum ciet tumorem in aëre circumquaque; ita ut aër ille novus ex resolutione vaporum plus conferat ad motum quam ad materiam; corpus autem magnum venti consistit ex aëre priore;

neque aër novus aërem veterem ante se agit, ac si corpora separata essent; sed utraque commista ampliorem locum desiderant.

5. Quando aliud concurrit principium motus præter ipsam superonerationem aëris, accessorium quippiam est illud, et principale fortificat et auget; unde fit, ut venti magni et impetuosi raro oriantur ex superoneratione aëris simplici.

6. Quatuor sunt accessoria ad superonerationem aëris; expiratio e subterraneis; dejectio ex media regione aëris (quam vocant); dissipatio ex nube facta; et mobilitas atque acrimonia exhalationis ipsius.

7. Motus venti quasi semper lateralis est; verum is qui fit per superonerationem simplicem, usque a principio; is qui fit per expirationem e terra aut repercussionem ab alto, non multo post; nisi eruptio aut præcipitium aut reverberatio fuerint admodum violenta.

8. Aër nonnullam compressionem tolerat, antequam superonerationem percipiat et aërem contiguum impellat; ex quo fit, ut omnes venti sint paulo densiores quam aër quietus.

9. Sedantur venti quinque modis; aut coëuntibus vaporibus; aut incorporatis; aut sublimatis; aut transvectis; aut destitutis.

10. Coëunt vapores, atque adeo ipse aër in pluviam, quatuor modis; aut per copiam aggravantem; aut per frigora condensantia; aut per ventos contrarios compellentes; aut per obices repercutientes.

11. Tam vapores, quam exhalationes, materia ventorum sunt. Etenim ex exhalationibus nunquam pluvia, ex vaporibus sæpissime venti. At illud interest, quod facti venti ex vaporibus facilius se incorporant aëri puro, et citius sedantur, nec sint tam obstinati, quam illi ex halitibus.

12. Modus et diversæ conditiones caloris, non minus possunt in generatione ventorum, quam copia aut conditiones materiæ.

13. Solis calor in generatione ventorum ita proportionatus esse debet, ut eos excitet, sed non tanta copia ut coëant in pluviam, nec tanta paucitate ut prorsus discutiantur et dissipentur.

14. Venti spirant ex parte fomitum suorum; eunque

fomites varie disponantur, diversi venti, ut plurimum, simul spirant; sed fortior debiliorem aut obruit aut flectit in currentem suum.

15. Ubique generantur venti, ab ipsa terræ superficie usque ad frigidam regionem aëris; sed frequentiores in proximo, fortiores in sublimi.

16. Regiones quæ habent ventos Asseclas ex tepidis, sunt calidiores quam pro ratione climatis sui; quæ ex gelidis, frigidiores.

Charta Humana; sive optativa cum proximis, circa ventos.

Optativa. 1. Vela navium ita componere et disponere, ut minore flatu majorem conficiant viam. Res insigniter utilis ad compendia itinerum per mare, et parcendum impensis.

Proximum. *Proximum* non occurrit adhuc inventum, præcise in practica. Sed consule de eo observationes majores super articulum 26.

Optativa. 2. Molendina ad ventum et vela ipsorum ita fabricari, ut minore flatu plus molant. Res utilis ad lucrum.

Proximum. Consule de hoc experimenta nostra in responso ad articulum 27, ubi videtur res quasi peracta.

Optativa. 3. Ventos orituros et occasuros, et tempora ipsorum, prænoscere. Res utilis ad navigationes et agriculturam; maxime autem ad electiones temporum ad prælia navalia.

Proximum. Huc multa pertinent eorum quæ in inquisitione, præsertim in responso ad articulum 32, notata sunt. At observatio in posterum diligentior (si quibus ea cordi erit), patescente jam causa ventorum, longe exactiora prognostica præstabit.

Optativa. 4. Judicium et prognostica facere per ventos de aliis rebus: veluti primo, si sint continentes aut insulæ in mari in aliquo loco, vel potius mare liberum? Res utilis ad navigationes novas et incognitas.

Proximum. *Proximum* est, observatio circa ventos Statos; id quo usus videtur Columbus.

Optativa. 5. Itidem de ubertate aut caritate fructuum et segetum, annis singulis. Res utilis ad lucrum, et ven-

ditiones anticipantes, et coëmptiones; ut proditum est de Thalete circa monopolium olivarum.[1]

Proximum. Huc pertinent nonnulla in inquisitione posita de ventis, aut malignis aut decussivis, et temporibus quando nocent, ad articulum 29.

Optativa. 6. Itidem de morbis et pestilentiis, annis singulis. Res utilis ad existimationem medicorum, si illa prædicere possint; etiam ad causas et curas morborum; et nonnulla alia civilia.

Proximum. Huc pertinent etiam nonnulla in inquisitione posita ad articulum 30.

Monitum. De prædictionibus ex ventis, circa segetes, fructus, et morbos, consule Historias Agriculturæ et Medicinæ.

Optativa. 7. Ventos excitare et sedare.

Proximum. De his habentur quædam superstitiosa et magica; quæ non videntur digna quæ in Historiam Naturalem seriam et severam recipiantur. Neque occurrit nobis aliquid *proximum* in hoc genere. Designatio ea esse poterit, ut natura aëris penitus introspiciatur et inquiratur; si possit inveniri aliquid, quod in quantitate non magna in aërem immissum possit excitare et multiplicare motum ad dilatationem aut contractionem in corpore aëris; ex hoc etenim (si fieri possit) sequentur excitationes et sedationes ventorum; quale est illud experimentum Plinii de aceto injecto in occursum turbinis, si verum foret.[2] Altera designatio possit esse per emissionem ventorum ex subterraneis, si congregentur alicubi in magna copia; quale est illud receptum de puteo in Dalmatia[3]; verum et loca hujusmodi carcerum nosse difficile.

Optativa. 8. Complura ludicra et mira per motum ventorum efficere.

Proximum. De his cogitationem suscipere nobis non est otium. *Proximum* est illud vulgatum duellorum ad ventum. Proculdubio multa ejusmodi jucunda reperiri possunt, et ad motus et ad sonos.

[1] Diog. Laert. i. 26. [2] Pliny, ii. 49. [3] Vide suprà, p. 41.

ADITUS AD TITULOS IN PROXIMOS QUINQUE MENSES DESTINATOS.

HISTORIA DENSI ET RARI.

ADITUS.

[For the *aditus* which follows in the original edition, see *Historia Densi et Rari.*]

HISTORIA GRAVIS ET LEVIS.

ADITUS.

Motum Gravitatis et Levitatis, veteres Motus Naturalis nomine insigniverunt. Scilicet nullum conspiciebant efficiens externum; nullam etiam resistentiam apparentem. Quinimo citatior videbatur motus iste in progressu suo. Huic contemplationi, vel sermoni potius, phantasiam illam mathematicam de hæsione gravium ad centrum terræ (etiam si perforata foret ipsa terra), nec non commentum illud scholasticum de motu corporum ad loca sua, veluti salem asperserunt. His positis, perfunctos se credentes, nil amplius quærebant, nisi quod de Centro Gravitatis in diversis figuris, et de iis quæ per aquam vehuntur, paulo diligentius quispiam ex illis quæsivit. Neque ex recentioribus quisquam operæ pretium circa hoc fecit, addendo solummodo pauca mechanica, eaque per demonstrationes suas detorta. Verum missis verbulis, certissimum est corpus non nisi a corpore pati; nec ullum fieri motum localem, qui non sollicitetur aut a partibus corporis ipsius quod movetur, aut a corporibus adjacentibus, vel in contiguo, vel in proximo, vel saltem intra orbem activitatis suæ. Itaque vires *magneticas* non inscite introduxit Gilbertus, sed et ipse factus *magnes;* nimio scilicet plura quam oportet ad illas trahens, et navem ædificans ex scalmo.

HISTORIA SYMPATHIÆ ET ANTIPATHIÆ RERUM.

ADITUS.

Lis et Amicitia in natura stimuli sunt motuum, et claves operum. Hinc corporum unio et fuga, hinc partium mistio et separatio, hinc altæ atque intimæ impressiones virtutum, et quod vocant conjungere activa cum passivis; denique magnalia naturæ. Sed impura est admodum hæc pars philosophiæ de Sympathia et Antipathia rerum, quam etiam *Naturalem Magiam* appellant, atque (quod semper fere fit) ubi diligentia defuit, spes superfuit. Operatio autem ejus in hominibus prorsus similis est soporiferis nonnullis medicamentis, quæ somnum conciliant, atque insuper læta et placentia somnia immittunt. Primo enim intellectum humanum in soporem conjicit, decantando proprietates specificas, et virtutes occultas et cœlitus demissas; unde homines ad veras causas eruendas non amplius excitantur et evigilant, sed in hujusmodi otiis acquiescunt; deinde innumera commenta, somniorum instar, insinuat et spargit. Sperant etiam homines vani Naturam ex fronte et persona cognoscere, et per similitudines extrinsecas proprietates internas detegere. Practica quoque inquisitioni simillima. Præcepta enim Magiæ Naturalis talia sunt, ac si confiderent homines terram subigere et *panem suum comedere* absque *sudore vultus*, et per otiosas et faciles corporum applicationes rerum potentes fieri; semper autem in ore habent et tanquam sponsores appellant Magnetem et consensum Auri cum Argento Vivo, et pauca hujus generis, ad fidem aliarum rerum, quæ neutiquam simili contractu obligantur. Verum optima quæque laboribus, tum inquirendi tum operandi, proposuit Deus. Nos in jure naturæ enucleando et rerum fœderibus interpretandis paulo diligentiores erimus; nec miraculis faventes, nec tamen inquisitionem instituentes humilem aut angustam.

HISTORIA SULPHURIS, MERCURII, ET SALIS.

ADITUS.

Principiorum Trias istud a Chimistis introductum est; atque quoad speculativa, est ex iis quæ illi afferunt inventum optimum. Subtiliores ex iis, quique philosophantur maxime, Elementa volunt esse Terram, Aquam, Aërem, Æthera. Illa autem non Materiam rerum esse ponunt, sed Matrices; in quibus specifica semina rerum generant, pro natura matricis. Pro Materia autem Prima (quam spoliatam et adiaphoram ponunt Scholastici) substituunt illa tria, Sulphurem, Mercurium, et Salem; ex quibus omnia corpora sint coagmentata et mista. Nos vocabula ipsorum accipimus; dogmata parum sana sunt. Illud tamen non male cum illorum opinione convenit, quod duo ex illis, Sulphurem scilicet et Mercurium, (sensu nostro accepta) censemus esse naturas admodum primordiales, et penitissimos Materiæ Schematismos; et inter Formas Primæ Classis fere præcipuas. Variare autem possumus vocabula Sulphuris et Mercurii, ut ea aliter nominemus; oleosum, aqueum; pingue, crudum; inflammabile, non inflammabile; et hujusmodi. Videntur enim esse hæ duæ Rerum Tribus magnæ prorsus, et quæ universum occupant et penetrant. Siquidem in subterraneis, sunt Sulphur et Mercurius, ut appellantur; in vegetabili et animali genere, sunt Oleum et Aqua; in pneumaticis inferioribus, sunt Aër et Flamma; in cœlestibus, Corpus Stellæ et Æther Purum; verum de ultima hac dualitate nil adhuc pronunciamus, licet probabilis videatur esse symbolizatio. Quod vero ad Salem attinet; alia res est. Si enim Salem intelligunt pro parte corporis fixa, quæ neque abit in flammam neque in fumum; pertinet hoc ad Inquisitionem Fluidi et Determinati; de quibus nunc non est sermo; sin Salem accipi volunt secundum literam absque parabola, non est Sal aliquid tertium a

Sulphure et Mercurio, sed mistum ex utrisque per spiritum acrem devinctis. Etenim Sal omnis habet partes inflammabiles; habet alias, flammam non solum non concipientes, sed eam exhorrentes et strenue fugientes. Nihilominus cum inquisitio de Sale, sit quiddam affine inquisitioni de duobus reliquis, atque insuper sit eximii usus, utpote vinculum utriusque naturæ, Sulphureæ et Mercurialis [1], et vitæ ipsius rudimentum; illum etiam in hanc historiam et inquisitionem recipere visum est. At illud interim monemus, de Pneumaticis illis, Aëre, Flamma [2], Stellis, Æthere, nos illa (prout certe merentur) inquisitionibus propriis reservare; et de Sulphure et Mercurio tangibili (nimirum vel minerali, vel vegetabili et animali) hic tantum historiam instituere.

[1] *Salis* in the original edition; corrected in the edition of 1638. — *J. S.*
[2] *Aqua* in the original edition; corrected in ed. 1638. — *J. S.*

HISTORIA VITÆ ET MORTIS.

ADITUS.

[For the *aditus* which follows in the original edition, see *Historia Vitæ et Mortis*, p. 105.]

FRAGMENTUM LIBRI VERULAMIANI,

CUI TITULUS,

ABECEDARIUM NATURÆ.[1]

Cum tam multa producantur a terra et aquis, tam multa pertranseant aërem et ab eo excipiantur, tam multa mutentur et solvantur ab igne, minus perspicuæ forent inquisitiones cæteræ, nisi natura massarum istarum, quæ toties occurrunt, bene cognita et explicata. His adjungimus inquisitiones de Cœlestibus et Meteoricis, cum et ipsæ sint Massæ majores, et ex Catholicis.

Massæ Majores. Inquisitio sexagesima septima. Triplex Tau[2], sive de Terra.

Massæ Majores. Inquisitio sexagesima octava. Triplex Upsilon, sive de Aqua.

Massæ Majores. Inquisitio sexagesima nona. Triplex Phi, sive de Aëre.

[1] From the first paragraph of the *Norma Historiæ Præsentis* (sup. p. 17.) it appears that Bacon intended to add at the end of the volume an *Abecedarium* of abstract natures; and in Dr. Rawley's list of the works composed by him during the last five years of his life (which he enumerates, as nearly as he can, in the order in which they were written), the second in order, immediately preceding the *Historia Ventorum*, is "*Abecedarium Naturæ*, or a metaphysical piece, *which is lost*." It seems probable therefore that when the volume was published this was not to be found. The fragment which follows was discovered among Bacon's papers by Dr. Tenison, and published in his *Baconiana*, p. 77. Supposing it to be a part of the lost work, I have thought this the proper place for it. The *Norma Abecedarii*, with which it concludes, was probably intended originally to be prefixed, like the *Norma Historiæ Præsentis*, of which it is obviously a rudiment; but this must have been when the *Abecedarium* was meant to stand by itself, or to come first; the *Historia Ventorum* not being yet written. Had it been placed at the end of the volume, as intended, the *Norma* would doubtless have been omitted.—*J. S.*

[2] As τ is the nineteenth of the twenty-four letters of the Greek alphabet, it appears from this passage that Bacon proposed to denote the first twenty-four inquisitions by single Greek letters, the twenty-fifth by αα, and so on. For the sixty-seventh would thus be denoted by ττ τ, sixty-seven being equal to the sum of forty-eight and nineteen.

Massæ Majores. Inquisitio septuagesima. Triplex Chi, sive de Igne.

Massæ Majores. Inquisitio septuagesima prima. Triplex Psi, sive de Cœlestibus.

Massæ Majores. Inquisitio septuagesima secunda. Triplex Omega, sive de Meteoricis.

Conditiones entium.

Supersunt ad inquirendum in Abecedario Conditiones Entium quæ videntur esse tanquam transcendentia, et parum stringunt de corpore naturæ, tamen eo quo utimur inquirendi modo haud parum afferent illustrationis ad reliqua. Primo igitur, cum optime observatum fuerit a Democrito, naturam rerum esse copia materiæ et individuorum varietate amplam, atque (ut ille vult) infinitam; coitionibus vero et speciebus in tantum finitam, ut etiam angusta et tanquam paupercula videri possit[1]; quandoquidem tam paucæ inveniantur species quæ sint aut esse possint, ut exercitum millenarium vix conficiant; cumque negativa affirmativis subjuncta ad informationem intellectus plurimum valeant; constituenda est inquisitio de Ente, et non Ente. Ea ordine est septuagesima tertia, et quadruplex Alpha numeratur.

Conditiones entium. Quadruplex Alpha; sive de Ente et non Ente.

At Possibile et Impossibile nil aliud est, quam Potentiale ad Ens aut non Potentiale ad Ens. De eo inquisitio septuagesima quarta conficitor; quæ quadruplex Beta numeratur.

Conditiones entium. Quadruplex Beta; sive de Possibili et Impossibili.

[1] Bacon seems to have been misled by supposing that the opinions of Democritus are in all points represented by those of Lucretius. For Democritus certainly affirmed that as there is an infinite variety of phenomena, so likewise there must be a corresponding, and therefore infinite variety of atomic σχημάτα. See *Mullach, Democrit. Abder. Oper. Fragm.* p. 381. On the other hand, Lucretius says, *De Rer. Nat.* ii. 512:—

"fateare necesse est
Materiam quoque finitis differre figuris."

According to him there is a finite number of σχημάτα or formæ, each of which must be repeated an infinite number of times, as the universe itself is infinite. The doctrine of Epicurus on this subject seems to be intermediate between those of Democritus and of Lucretius. See Diog. Laert. For the substance of this note I am indebted to Mr. Munro, fellow of Trinity College, Cambridge

Etiam Multum, Paucum, Rarum, Consuetum, sunt Potentialia ad Ens in Quanto. De iis inquisitio septuagesima quinta esto, quæ quadruplex Gamma numeretur.

Conditiones entium. Quadruplex Gamma; sive de Multo et Pauco.

Durabile et Transitorium, Æternum et Momentaneum, sunt Potentialia ad Ens in Duratione. De illis septuagesima sexta inquisitio esto, quæ quadruplex Delta numeratur.

Conditiones entium. Quadruplex Delta; sive de Durabili et Transitorio.

Naturale et Monstrosum sunt Potentialia ad Ens, per cursum naturæ, et per deviationes ejus. De iis inquisitio septuagesima septima esto, quæ quadruplex Epsilon numeratur.

Conditiones entium. Quadruplex Epsilon; sive de Naturali et Monstroso.

Naturale et Artificiale sunt Potentialia ad Ens, sine homine, et per hominem. De iis inquisitio septuagesima octava conficitor, quæ quadruplex Zeta numeretur.

Conditiones entium. Quadruplex Zeta; sive de Naturali et Artificiali.

Exempla in explicatione ordinis Abecedarii non adjunximus, quia ipsæ inquisitiones continent totas acies exemplorum.

Tituli secundum quos ordo Abecedarii est dispositus, nullo modo eam authoritatem habento, ut pro veris et fixis rerum divisionibus recipiantur. Hoc enim esset profiteri scire nos quæ inquirimus. Nam nemo res vere dispertit, qui non naturam ipsarum penitus cognovit. Satis sit, si ad ordinem inquirendi (id quod nunc agitur) commode se habeant.

NORMA ABECEDARII.

ABECEDARIUM hoc modo conficimus et regimus. Historia et experimenta omnino primas partes tenent. Ea, si enumerationem et seriem rerum particularium exhibeant, in tabulas conficiuntur; aliter sparsim excipiuntur.

Cum vero historia et experimenta sæpissime nos deserant,

præsertim lucifera illa, et instantiæ crucis, per quas de veris rerum causis intellectui constare possit; mandata damus de experimentis novis. Hæc sint tanquam Historia Designata. Quid enim aliud nobis primo viam ingredientibus relinquitur?

Modum experimenti subtilioris explicamus, ne error subsit, atque ut alios ad meliores modos excogitandos excitemus.

Etiam monita et cautiones de rerum fallaciis et inveniendi erroribus, quæ nobis occurrunt, aspergimus. Observationes nostras super historiam et experimenta subteximus, ut interpretatio naturæ magis sit in procinctu.

Etiam canones, sed tamen mobiles, et axiomata inchoata, qualia nobis inquirentibus, non pronunciantibus, se offerunt, constituimus: utilia enim sunt, si non prorsus vera.[1]

Denique tentamenta quædam interpretationis quandoque molimur, licet prorsus humi repentia, et vero interpretationis nomine nullo modo (ut arbitramur) decoranda. Quid enim nobis supercilio opus est aut impostura, cum toties profiteamur, nec nobis historiam et experimenta, qualibus opus est, suppetere, nec absque his interpretationem naturæ perfici posse, ideoque nobis satis esse, si initiis rerum non desimus?

Perspicuitatis autem et ordinis gratia, aditus quosdam ad inquisitiones, instar præfationum, substernimus: item connexiones et vincula, ne inquisitiones sint magis abruptæ, interponimus.

Ad usum vero vellicationes quasdam de practica suggerimus.

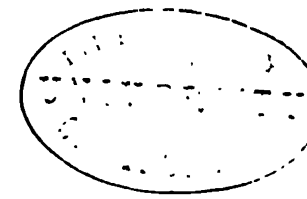
Etiam optativa eorum, quæ adhuc non habentur, una cum proximis suis, ad erigendam humanam industriam, proponimus.

Neque sumus nescii, inquisitiones inter se aliquando complicari, ita ut nonnulla ex inquisitis in titulos diversos incidant. Sed modum eum adhibebimus, ut et repetitionum fastidia et rejectionum molestias, quantum fieri possit, vitemus; postponentes tamen hoc ipsum (quando necesse fuerit) perspicuitati docendi, in argumento tam obscuro.

Hæc est Abecedarii norma et regula. Deus universi Conditor, Conservator, et Instaurator, opus hoc et in ascensione ad gloriam suam et in descensione ad bonum humanum, pro sua erga homines benevolentia et misericordia, protegat et regat, per Filium suum unicum nobiscum Deum.

[1] *Utiles* and *veræ* in the original.—*J. S.*

HISTORIA VITÆ ET MORTIS.



PREFACE

TO THE

HISTORIA VITÆ ET MORTIS.

BY ROBERT LESLIE ELLIS.

Of the five treatises which in the dedication of the *Historia Naturalis* Bacon proposes to publish in five successive months, or even within a shorter period, the *Historia Vitæ et Mortis* stands last in the list of titles. But it was Bacon's intention that it should be published next in order to the *Historia Ventorum*, and this intention was fulfilled, though not as soon as he had proposed; the *Historia Vitæ et Mortis* not being published until 1623.

Bacon's reason for giving it precedence of the other histories is mentioned in the Aditus or preface, — the extreme importance of the subject to which it relates, namely "the prolongation and setting up of human life,"[1] a matter "in quâ vel minima temporis jactura pro pretiosâ haberi debet." Yet we may surely be permitted to doubt whether it be wise to regard longevity as in itself a thing desirable, and whether we are at liberty to seek to prolong life by other appliances than those by which health may be improved, or at least by which it cannot be impaired. If health and long life can be regarded as independent objects of pursuit, it may be said that we are bound to make our option for the former, seeing that we come into the world to perform duties for which enfeebled health more or less unfits us, and that it would be no addition to human happiness if we could succeed in making all men long-lived valetudinarians. Moreover, it is hard to see how the systematic pursuit of longevity is to be reconciled with the professions of men who speak of themselves as sojourners upon the

[1] Vita hominum proroganda et instauranda.

earth and pilgrims. This difficulty Bacon himself perceived; and both in the following Aditus and in a corresponding passage in the *De Augmentis* where he is explicitly speaking of long life as a distinct object of pursuit, he remarks that though to Christian men the world is but a wilderness, yet it is to be accounted a blessing if our shoes and garments do not wax old by the way; an illustration by which the difficulty is not removed. Not to insist upon it, and admitting that the love of life is at any rate the most natural of all weaknesses, we may yet regard it as a happy circumstance that long life is apparently not to be attained by artificial means, and certainly not by means which tend to endanger health.

In the passage of the *De Augmentis* already referred to, Bacon complains that physicians have not sufficiently recognised the prolongation of life as one of the objects which their art should seek to obtain. The question had however been asked, whether life could be prolonged by other means than those which are used to preserve health, or to improve it. Thus Flacius in his *Commentatio de Vitâ et Morte* [1584] decides this question by asserting that health and longevity depend on the same causes, and must therefore be promoted by the same means.[1] But from this view Bacon altogether dissents; and he therefore divides the duty of the physician into three distinct parts: the preservation of health; the cure of diseases; and the prolongation of life. In speaking of the last, he warns men not to confound the treatment which conduces to health with that which conduces to long life. Some things there are, he says, which promote the alacrity of the spirits and increase the vigour of the functions, and are of use in warding off disease; and which nevertheless shorten life and accelerate the decay of old age. Contrariwise there are others which are of use in lengthening life, and yet cannot be used without endangering health; wherefore they who employ them must obviate the inconveniences which they might else occasion by other means.

The *Historia Vitæ et Mortis* is in fact an essay on this third part of medicine, "quæ nova est et desideratur, estque omnium nobilissima." In none of Bacon's writings is there more appearance of research; he has collected a great number of instances of longevity, and in attempting to find something

[1] Flacius, iv. 23.

in the character or way of life of the persons whom he mentions to which their long life may be ascribed, he often sums up with singular felicity whatever is most remarkable about them. Still it cannot be said that the theory on which he relies for the prolongation of life has much connexion with the facts which he has collected, and in truth no general inference can seemingly be derived from them, except perhaps that for the most part those men live longest in whom the spirit of life is the most vigorous. For the theory itself, which is based upon that of the animal spirits, not much can now be said; but the way in which it is set forth and the remarks by which it is accompanied have been much commended by one of the greatest of medical writers. Haller, in his edition of Boerhaave's *Methodus Stud. Medicin.*[1], speaks thus of the *Historia Vitæ et Mortis*: "Causam equidem mortis falsam adlegat, non satis cautus a præjudicatâ opinione, spiritum nempe vitalem exhalantem. Multum historiarum confert ad longævitates plantarum, animalium, hominum. Sapientia denique consilia dat, quibus longævitas obtineri queat, nitro, opio, purgationibus subinde repetitis, validis, omnium mediocritate, rejectis nugacibus opinionibus quæ eo tempore dominabantur." He gives a fuller account of it in the *Bibliotheca Medica*. . . . "Spiritum vitalem aëre puriorem, igne mitiorem, habitare in corpore animali et viscidioribus particulis irretiri, ea vero vincula paulatim evadere, denique exhalare, eam esse mortis naturalis causam. Spem longævitatis esse in retardandâ hujus spiritus evolutione dum inviscatur, pori per quos exhalat obstruuntur, calor diminuitur. Ad longævitatem ergo pertinere vitam minus actuosam, opium, nitrum, somnum longiorem, purgationem alvi, diætam debilitantem. Homines qui salivationem passi sunt, aut alioquin ad summam macilentiam redacti, postquam convaluerunt, iidem ad longam ætatem perveniunt. Ad longævitatem spem facere periodos vitæ majores, ingenium non fervidissimum, incrementum lentius, corpus siccius, succorum subinde renovationem, vitam etiam parcissimam, contemplationi deditam. Aurum, margaritas, lapides pretiosos parvi facit. Aëris exclusionem, vitam in speluncis laudat, alimenta firma, carnes duriores, stomachum

[1] I. 56. In the passage to which Haller's remark is a note, Boerhaave speaks in the highest terms of Bacon, and concludes by saying: "Quidquid Cartesius habet, si quid boni habet, hoc unice isti debet, neque melior autor haberi potuit, licet ejus nomen ab imperitis adeo supprimatur."

per vina styptica confirmatum, frictionem, inunctionem, corporis exercitationem modicam, balnea.

"Denique mortis historia. Perire animal quando spiritus motus supprimitur, quando denegatur refrigerium, quo strangulatio pertinet, quando reparatio inhibetur per inediam, aut depletionem vasorum. Atriola mortis, s. symptomata quæ vitæ finem præcedunt, quo etiam pulsus subpressus et vacillans. Restitutio submersorum. Quæ cuique ætati propria sint, juventuti, senio. Multiplex ubique eruditio et ingenii vis." [1]

The idea on which Bacon's theory of longevity is founded, namely that the principle of life resides in a subtle fluid or spirit which permeates the tangible parts of the organisation of plants and animals, seems to be coeval with the first origin of speculative physiology. Bacon was one of those by whom this idea was extended from organised to inorganic bodies: in all substances, according to him, resides a portion of spirit which manifests itself only in its operations, being altogether intangible and without weight.[2] This doctrine appeared to him to be of most certain truth, but he has nowhere stated the grounds of his conviction, nor even indicated the kind of evidence by which the existence of the spiritus is to be established. In living bodies he conceived that two kinds of spirits exist: a crude or mortuary spirit, such as is present in other substances; and the animal or vital spirit, to which the phenomena of life are to be referred. To keep this vital spirit, the wine of life, from oozing away, ought to be the aim of the physician who attempts to increase the number of our few and evil days.

With respect to the instances of long life which Bacon has collected, it would be well to ascertain the sources from which his information was derived. But it is hardly possible to do this, at least in all cases, and in some I have even failed in obtaining any information as to the age at which the persons in question died. I am inclined to believe that Bacon was in the habit of noting down instances of longevity as they occurred to him in the course of his reading. Thus he mentions the age of Ovid's father, which is only known from a passage in the *Tristia*. He has made use of all the instances of longevity mentioned by Pliny and by Valerius Maximus, and seems to have consulted some of the works composed in imitation of the

[1] Haller, Bibl. Med. ii. 512. [2] This notion is prominent in the writings of Paracelsus.

latter by modern writers. The earliest of these is perhaps the *Res Memorandæ* of Petrarch; the most often quoted is Fulgosius's *Facta dictaque memorabilia.* Egnatius's collection, entitled *De Exemplis illustrium virorum Venetæ civitatis et aliarum gentium,* is the one which there is the most reason to believe that Bacon made use of. Three remarkable instances of longevity are mentioned by Egnatius and by Bacon in the same order. All these works (there are probably others of the same class) resemble that of Valerius Maximus, or rather the collection commonly ascribed to him, in consisting of anecdotes arranged under various heads, and subdivided by a general principle of classification. Thus in the case of Valerius Maximus, we have a chapter on valour, on piety, and so on, each containing two sections, of which the first contains Roman and the other foreign instances of the subject of the chapter. Each chapter of Petrarch's collection is divided into three heads: Roman, foreign, and recent examples being placed together. Fulgosius divides each chapter into two sections, of which the second contains "Recentiora." Egnatius's collection having especial reference to Venice, he classes Venetian instances in a division of their own, and the remainder of each chapter consists of all others. In all these works there is a chapter entitled "Senectus," and Bacon may perhaps have referred to them all. The great age which was attained by Gartius Aretinus is first mentioned by his great-grandson Petrarch. But though Bacon repeats Petrarch's statement, it by no means follows that he had found it in Petrarch's book. The story is told also by Fulgosius and probably by many other writers, among whom I may particularly mention Theodore Zwinger. For there seems reason to believe that Bacon was acquainted with Zwinger's *Theatrum Vitæ Humanæ,* the greatest collection that was ever made of miscellaneous anecdotes. We find in the *Historia Vitæ et Mortis* that the grandfather of Apollonius of Tyana attained the age of one hundred and twenty years. Now in the life of Apollonius by Philostratus, which is the source from which we derive almost all that is related of him and of his kindred, nothing of the kind is mentioned. But in the first of Zwinger's folios we find the same statement as in Bacon. Zwinger refers to Raphael Volaterrensis, from whom those who depreciate the *Theatrum Vitæ Humanæ* affirm that a great deal of it is taken. Under the head of Apollonius we find in the

Commentationes Urbanæ a summary of his life. During his travels in the East Apollonius sojourned for a while with a college of Indian priests, one of whom, in a conversation recorded at much length by Philostratus, informed him of many things touching their discipline and way of life. In this conversation he is incidentally led to tell him that his grandfather, also a member of the sacerdotal college, lived to be a hundred and twenty. Raphael Volaterrensis repeats this story in a way by which a careless reader might be led to suppose that Apollonius's grandfather, and not the priest's, is the person spoken of. We have here the origin of Zwinger's mistake; and as it is not probable that two persons should have made it, we may conclude that Bacon's information was taken from the *Theatrum Vitæ*. I have thought the history of this error worth noticing, because (excepting Paracelsus) there is scarcely any obvious trace in Bacon's writings of his being acquainted with any Swiss or German author. This story is in itself somewhat instructive, especially as Bacon draws an inference from the error which he has adopted. Apollonius, he observes, lived to a great age, which is not wholly to be ascribed to his way of life, seeing that his grandfather did so too, so that he probably came of a long-lived stock. Thus history is often written,—the longevity of the family of Apollonius resting on no better foundation than that a compiler mistook the meaning of a statement which his predecessor had copied from an author of no good credit. There is another not wholly dissimilar mistake in the *Historia Vitæ et Mortis*. Bacon gives a short character of Asinius Pollio in connexion with a statement that he lived more than a hundred years. Now, though Asinius Pollio died an old man[1], he is clearly introduced here because he was confounded with Pollio Romilius, of whom Pliny relates that when he was past a hundred he had an interview with Augustus, a circumstance reproduced in Bacon's transformation of the story in the phrase "Asinius Pollio Augusti familiaris."

Bacon on the other hand deserves credit for having perceived that the story of Seneca's great age was incredible: he was not, however, aware of the origin of the mistake, which according to Antonius was first explained by Raphael Volaterrensis, and which I find mentioned, not long afterwards, in Cardan's *Paralipomena*.

[1] About eighty or eighty-two.

Bacon's description of Postellus seems to show that while he was in France he had met with that singular and unhappy man. What is said of his great age rests probably on no better authority than his own: there seems no good reason to believe that he was much more than seventy when he died, though Bacon affirms that he was nearly a hundred and twenty. It would be quite in accordance with what we know of Postellus to suppose that he made himself much older than he really was in order to increase the wonder with which he was regarded. This kind of deception is not unfrequent, and it will, generally speaking, be more or less successful. The love of marvels and the sweetness of life incline men to believe in stories of extreme longevity, and when a man has grown old he meets but few who know when he was born.

Bacon's remark that out of all the popes four only had reached eighty is certainly incorrect. At least five others ought to be added to the list, of whom one, Benedict XIII. [1], was the first by whom the ominous by-word, "Non videbis annos Petri," was shown to be not necessarily true. Why the popes live so short a time after their elevation was an old question. Alexander II. proposed it to Peter Damiani, who answered it by saying that providence meant to show us how transitory a thing is human greatness.

Peter Ravennas, some centuries later, sought to explain the fact by natural causes. He gives a list of all the popes, enumerating the number of years during which each reigned,—a thing in all cases, or in almost all, well ascertained, whereas the age at which a pope has died cannot always be discovered.

The *Historia Vitæ et Mortis* is the only work of its author in which I have been able to find distinct evidence of his acquaintance with any of the writings of Roger Bacon. It has often been said that the four idola of Francis Bacon are derived from the four hindrances to knowledge mentioned in the *Opus Majus*, and no doubt it is possible that this is true. But except the sameness of the number, there is not much analogy between them; and the number four presents itself to the mind in so many combinations that it is not remarkable that it should enter into two independent classifications.[2]

[1] Pedro de Luna, who ought in strictness to be accounted an antipope.

[2] Moreover, the number of F. Bacon's *Idols* was originally three. See Vol. I. pp. 90. and 114.—*J. S.*

As for what is said that Roger Bacon had, like his namesake, asserted the necessity of observation and experiment, we need not look so far back to find writers of whom we may suppose that in this respect Francis Bacon was the disciple. Nor is it likely that Bacon studied an author, almost all whose works were still in manuscript, and who apparently belonged to a class of writers whom he held in very little respect. But of Roger Bacon's tract *De Mirabil. Potest. Artis et Naturæ*, an English translation was published in 1618, from a copy in the possession of the occult philosopher Dr. Dee. In this we find one or two stories which are repeated in the *Historia Vitæ et Mortis*, but which Bacon however disbelieves, and not without reason. That of the *Lady of Formerey* is clearly a legendary tale;—how she was seeking a white doe, and how she met with a forest ranger, who had renewed his youth by anointing himself with an ointment which he had found somewhere within the verge of the forest.[1] Roger Bacon's treatise *De Retard. Senect. Accidentibus* was published in English in 1683. I do not find any reason for supposing that Bacon was acquainted with it. It contains one mystical chapter touching an occult method for the recovery of youth which the translator supposes, and perhaps rightly, to relate to a practice in support of which a passage of the Old Testament has been often quoted. A celebrated book was written in the middle of the last century on the same subject, or on something akin to it.[2] But it has unfortunately not been found possible by any embrace to hinder the flight of youth, or to recall it when it has fled.

> Ter frustra comprensa manus effugit imago,
> Par levibus ventis nigroque simillima somno.

Bacon alludes briefly to the same idle fancy, and refers in doing so to Marsilius Ficinus, from whose treatise *De Vitâ producendâ* he has taken one or two remarks. With the *Theognosta* of Cardan he was apparently not acquainted. The second book of it treats of the prolongation of life, and Bacon would probably have quoted from it the reply of a kinsman of

[1] She is called the Lady of the Wood in Dee's version, and in the original text published in the *Bibliotheca Chemica Curiosa*, Domina de Nemore. But in the edition published in Paris in 1542, and in an extract in the *Theatrum Chemicum*, her title is Domina de Formerey, from which the other reading may easily have been corrupted.

[2] "Hermippus Redivivus," by Cohausen. The title is taken from an apocryphal inscription commemorating the death of one Hermippus at the age of 115, and recording the means whereby he was enabled to live so long.

Cardan's who affirmed that his long life was owing to his never being out of doors before sunrise or after sunset. The rule is at least as good as that of the old man whom Bacon quotes, who always ate before he was hungry, and drank before he was thirsty. Another of these oracular sayings, — "Oil without, honey within,"—which Bacon ascribes to the mythical Johannes de Temporibus, seems to be more justly due to Democritus, to whom it is attributed in the *Geoponica*. That of Pollio Romilius is much to the same purpose—"Intus mulso, foris oleo."

Pliny and Aristotle are Bacon's principal authorities for what is said of the ages of different kinds of animals. From this part of the subject Bacon draws some inferences which are not perhaps without value.

The whole treatise concludes with thirty-two "Canones Mobiles," or provisionally affirmed results. They contain the sum of his theory, of which the passage I have quoted from Haller seems to give an adequate idea.

FRANCISCI

BARONIS DE VERVLAMIO,

VICE-COMITIS SANCTI ALBANI,

HISTORIA VITÆ ET MORTIS.

SIVE

TITVLVS SECVNDVS

IN HISTORIA NATURALI ET EXPERIMENTALI

AD CONDENDAM PHILOSOPHIAM:

QUÆ EST INSTAURATIONIS MAGNÆ PARS TERTIA.

LONDINI,

IN OFFICINA IO. HAVILAND, IMPENSIS MATTHÆI LOWNES.

1623.

VIVENTIBUS ET POSTERIS

SALUTEM.

Cum Historiam Vitæ et Mortis inter sex designationes menstruas ultimo loco posuerimus; omnino hoc prævertere visum est, et secundam edere, propter eximiam rei utilitatem; in qua vel minima temporis jactura pro pretiosa haberi debet. Speramus enim et cupimus futurum, ut id plurimorum bono fiat; atque ut medici nobiliores animos nonnihil erigant, neque toti sint in curarum sordibus; neque solum propter necessitatem honorentur, sed fiant demum omnipotentiæ et clementiæ divinæ administri, in vita hominum proroganda et instauranda; præsertim cum hoc agatur per vias tutas et commodas et civiles, licet intentatas. Etsi enim nos Christiani ad Terram Promissionis perpetuo aspiremus et anhelemus; tamen interim itinerantibus nobis in hac Mundi Eremo, etiam calceos istos et tegmina (corporis scilicet nostri fragilis) quam minimum atteri, erit signum Favoris Divini.

HISTORIA VITÆ ET MORTIS.

ADITUS.

De *vita brevi et arte longa*, vetus est cantilena et querela. Videtur igitur esse tanquam ex congruo, ut nos, qui pro viribus incumbimus ad artes perficiendas, etiam de *vita hominum producenda* cogitationem suscipiamus, favente et Veritatis et Vitæ Authore. Etsi enim vita mortalium non aliud sit quam cumulus et accessio peccatorum et ærumnarum, quique ad æternitatem aspirant iis leve sit lucrum vitæ; tamen non despicienda est, etiam nobis Christianis, operum charitatis continuatio. Quinetiam discipulus amatus cæteris superstes fuit; et complures ex patribus, præsertim monachis sanctis et eremitis, longævi fuerunt[1]; ut isti benedictioni (toties in lege veteri repetitæ) minus detractum videatur post ævum Servatoris, quam reliquis benedictionibus terrenis. Verum ut hoc pro maximo bono habeatur, proclive est. De modis assequendi, ardua inquisitio; eoque magis, quod sit et opinionibus falsis et præconiis vanis depravata. Nam et quæ a turba medicorum de Humore Radicali et Calore Naturali dici solent, sunt seductoria; et laudes immodicæ Medicinarum Chymicarum primo inflant hominum spes, deinde destituunt.

Atque de morte quæ sequitur ex suffocatione, putrefactione, et variis morbis, non instituitur præsens inquisitio; pertinet enim ad Historiam Medicinalem; sed de ea tantum morte quæ fit per resolutionem ac atrophiam senilem. Attamen de ultimo passu mortis, atque de ipsa extinctione vitæ, quæ tot modis et exterius et interius fieri potest (qui tamen habent quasi atriolum commune, antequam ad articulum mortis ventum sit), inquirere, affine quiddam præsenti inquisitioni esse censemus; sed illud postremo loco ponemus.

[1] *Fuerint* in the original. — *J. S.*

Quod reparari potest sensim, atque primo Integro non destructo, id potentia æternum est, tanquam Ignis Vestalis. Cum igitur viderent medici et philosophi, ali prorsus animalia, eorumque corpora reparari et refici; neque tamen id diu fieri, sed paulo post senescere ea, et ad interitum propere deduci; mortem quæsiverunt in aliquo quod proprie reparari non possit: existimantes Humorem aliquem Radicalem et Primigenium non reparari in solidum, sed fieri jam usque ab infantia appositionem quandam degenerem, non reparationem justam; quæ sensim cum ætate depravetur, et demum pravum deducat ad nullum. Hæc cogitarunt imperite satis et leviter. Omnia enim in animali, sub adolescentia et juventute, reparantur integre; quinetiam ad tempus quantitate augentur, qualitate meliorantur; ut materia reparationis quasi æterna esse posset, si modus reparationis non intercideret. Sed revera hoc fit. Vergente ætate, inæqualis admodum fit reparatio; aliæ partes reparantur satis fœliciter, aliæ ægre et in pejus; ut ab eo tempore corpora humana subire incipiant tormentum illud Mezentii, ut *viva in amplexu mortuorum immoriantur*, atque facile reparabilia, propter ægre reparabilia copulata, deficiant. Nam etiam post declinationem et decursum ætatis, spiritus, sanguis, caro, adeps, facile reparantur; at quæ sicciores aut porosiores sunt partes, membranæ et tunicæ omnes, nervi, arteriæ, venæ, ossa, cartilagines, etiam viscera pleraque, denique organica fere omnia, difficilius reparantur, et cum jactura. Illæ autem ipsæ partes, cum ad illas alteras reparabiles partes actu reparandas omnino officium suum præstare debeant, activitate sua ac viribus imminutæ, functiones suas amplius exequi non possunt. Ex quo fit, ut paulo post omnia ruere incipiant, et ipsæ illæ partes quæ in natura sua sunt valde reparabiles, tamen deficientibus organis reparationis, nec ipsæ similiter amplius commode reparentur, sed minuantur, et tandem deficiant. Causa autem periodi ea est; quod spiritus, instar flammæ lenis, perpetuo prædatorius, et cum hoc conspirans aër externus, qui etiam corpora sugit et arefacit, tandem officinam corporis et machinas et organa perdat, et inhabilia reddat ad munus reparationis. Hæ sunt veræ viæ mortis naturalis bene et diligenter animo volvendæ. Etenim qui naturæ vias non noverit, quomodo is illi occurrere possit, eamque vertere?

Itaque duplex debet esse inquisitio; altera de consumptione aut deprædatione corporis humani; altera de ejusdem repa-

ratione aut refectione: eo intuitu, ut altera, quantum fieri possit, inhibeatur, altera confortetur. Atque prior istarum pertinet præcipue ad spiritus et aërem externum, per quos fit deprædatio; secunda ad universum processum alimentationis, per quem fit restitutio. Atque quoad primam inquisitionis partem, quæ est de consumptione, omnino illa cum corporibus inanimatis, magna ex parte, communis est. Etenim quæ spiritus innatus (qui omnibus tangibilibus, sive vivis sive mortuis, inest) et aër ambiens operatur super inanimata, eadem et tentat super animata; licet superadditus spiritus vitalis illas operationes partim infringat et compescat, partim potenter admodum intendat et augeat. Nam manifestissimum est, inanimata complura absque reparatione ad tempus bene longum durare posse: at animata, absque alimento et reparatione, subito concidunt et extinguuntur, ut et ignis. Itaque inquisitio duplex esse debet; primo contemplando corpus humanum, tanquam inanimatum et inalimentatum; deinde tanquam animatum et alimentatum. Verum hæc præfati, ad *Topica Inquisitionis* jam pergamus.

TOPICA PARTICULARIA;

SIVE

Articuli Inquisitionis de Vita et Morte.

1. De natura Durabilis et minus Durabilis in corporibus inanimatis, atque simul in Vegetabilibus, inquisitionem habeto; non copiosam aut legitimam, sed strictim et per capita, et tanquam in transitu.
2. De Desiccatione, Arefactione, et Consumptione corporum inanimatorum et vegetabilium; et de modis et processu per quos fiunt; atque insuper de desiccationis, arefactionis, et consumptionis prohibitione et retardatione, corporumque in suo statu conservatione; atque rursus de corporum, postquam semel arefieri cœperint, intenebratione et emollitione et revirescentia; diligentius inquirito.

NEQUE TAMEN de his ipsis perfecta aut accurata facienda est inquisitio, cum ex proprio titulo Durabilis hæc depromi debeant, cumque non sint in inquisitione præsenti principalia, sed lumen tantummodo præbeant ad Prolongationem et Instaurationem Vitæ in Animalibus. In quibus ipsis (ut jam dictum est) eadem fere usu veniunt, sed suo modo. Ab inquisitione autem circa Inanimata et Vegetabilia, transeat inquisitio ad Animalia præter Hominem.

3. De Animalium Longævitate et Brevitate Vitæ, cum circumstantiis debitis quæ ad hujusmodi ævitates videantur facere, inquirito.
4. Quoniam vero duplex est duratio corporum, altera in identitate simplici, altera per reparationem; quarum prima in inanimatis tantum obtinet, secunda in vegetabilibus et animalibus, et perficitur per Alimentationem; ideo de Alimentatione, ejusque viis et processu, inquirito: neque id ipsum exacte (pertinet enim ad titulos Assimilationis et Alimentationis), sed ut reliqua in transitu.

AB INQUISITIONE circa Animalia atque Alimentata, transeat illa ad Hominem: cum vero jam deventum sit ad subjectum inquisitionis principale, debet esse in omnibus inquisitio magis exacta, et numeris suis absoluta.

5. De Longævitate et Brevitate Vitæ in Hominibus, secundum ætates mundi, regiones, et climata, et loca nativitatis et habitationis, inquirito.
6. De longævitate et brevitate vitæ in hominibus, secundum propagines et stirpes suas (tanquam esset hæreditaria); atque etiam secundum complexiones, constitutiones, et habitus corporis, staturas, necnon modos et spatia grandescendi, atque secundum membrorum facturas et compages, inquirito.
7. De longævitate et brevitate vitæ in hominibus, secundum tempora nativitatis, ita inquirito, ut astrologica et schemata cœli in præsentia omittas; recipito tantum observationes (si quæ sint) plebeias et manifestas, de partubus septimo, octavo, nono, et decimo mense; etiam noctu, interdiu, et quo mense anni?
8. De longævitate et brevitate vitæ in hominibus, secundum victum, diætas, regimen vitæ, exercitia, et similia, inquirito. Nam quatenus ad aërem, in quo vivunt et morantur homines, de eo in articulo superiore de locis habitationis inquiri debere intelligimus.
9. De longævitate et brevitate vitæ in hominibus, secundum studia et genera vitæ et affectus animæ et varia accidentia, inquirito.
10. De medicinis quæ putantur vitam prolongare, seorsum inquirito.
11. De signis et prognosticis vitæ longæ et brevis, non illis quæ mortem denotant in propinquo (id enim ad historiam medicinalem pertinet), sed de iis quæ etiam in sanitate apparent et observantur, inquirito; sive sint physiognomica, sive alia.

HACTENUS INSTITUTA est inquisitio de longævitate et brevitate vitæ, tanquam inartificialis et in confuso; huic adjicere visum est inquisitionem artificialem, atque innuentem ad praxim, per Intentiones. Eæ genere sunt tres. Distributiones autem magis particulares intentionum earum proponemus, cum ad ipsam inquisitionem ventum erit. Tres illæ intentiones generales sunt: *prohibitio consumptionis; perfectio reparationis; renovatio veterationis.*

12. De iis quæ corpus in homine ab arefactione et consumptione conservant et eximunt, aut saltem inclinationem ad eas remorantur et differunt, inquirito.

13. De iis quæ pertinent ad universum processum alimentationis (unde fit reparatio in corpore hominis), ut sit proba, et minima cum jactura, inquirito.
14. De iis quæ purgant inveterata et reponunt nova, quæque etiam ea quæ jam arefacta et indurata sunt rursus intenerant et humectant, inquirito.

QUONIAM VERO difficile est vias ad mortem nosse, nisi ipsius mortis sedem et domicilium (vel antrum potius) perscrutatus sis et inveneris, de hoc facienda est Inquisitio; neque tamen de omni genere mortis, sed tantum de iis mortibus quæ inferuntur per privationem et indigentiam, non per violentiam; illæ enim sunt tantum, quæ ad Atrophiam Senilem spectant.

15. De articulo mortis, et de atriolis mortis quæ ad illum ducant, ab omni parte (si modo id fiat per indigentiam, et non per violentiam) inquirito.

POSTREMO, QUONIAM expedit nosse characterem et formam senectutis, quod fiet optime si differentias omnes in statu corporis et functionibus inter juventutem et senectutem diligenter collegeris, ut ex iis perspicere possis quid sit illud tandem quod in tot effectus frondescat, etiam hanc inquisitionem ne omittito.

16. De differentiis status corporis et facultatum in juventute atque in senectute; et si quid sit ejusmodi quod in senectute maneat neque minuatur, diligenter inquirito.

NATURA DURABILIS.

Historia.

Ad Art. 1. 1. Metalla in tantum ævum durant, ut tempus durationis ipsorum hominum observationem fugiat. Etiam quando solvuntur per ætatem, in rubiginem solvuntur, non per perspirationem; aurum autem per neutrum.

2. Argentum vivum, licet humidum sit et fluidum, atque per ignem facile fiat volatile, tamen (quod novimus) absque igne, per ætatem solam, nec consumitur neć contrahit rubiginem.

3. Lapides, præsertim duriores, et complura alia ex fossilibus, longi sunt ævi; idque licet exponantur in aërem; multo magis dum conduntur sub terra; attamen nitrum quoddam colligunt

lapides, quod illis est instar rubiginis. Gemmæ autem et crystalla, metalla ipsa ævo superant; attamen clarore suo nonnihil a longa ætate mulctantur.

4. Observatum est, lapides ex parte Boreæ citius temporis edacitate consumi, quam Austro expositos, idque et in pyramidibus et in templis et aliis ædificiis manifestum esse: ferrum contra, ad Austrum expositum, citius rubiginem contrahere, ad Septentrionem tardius, ut in bacillis illis ferreis aut cratibus quæ ad fenestras apponuntur liquet. Nec mirum, cum in omni putrefactione (qualis est rubigo) humiditas acceleret dissolutionem; in arefactione simplici, siccitas.

5. In vegetabilibus (loquimur de avulsis nec vegetantibus) stemmata arborum duriorum, sive trunci atque ligna et materies ex ipsis, per sæcula nonnulla durant. Partes autem stemmatis varie se habent; sunt enim quædam arbores fistulosæ, ut sambucus, in quibus pulpa in medio mollior sit, exterius durius; at in arboribus solidis, qualis est quercus, interius (quod cor arboris vocant) durat magis.

6. Folia plantarum et flores, etiam caules, exiguæ sunt durationis, sed solvuntur in pulverem seseque incinerant, nisi putrefiant; radices autem sunt magis durabiles.

7. Ossa animalium diu durant, ut videre est in ossuariis, scilicet repositoriis ossium defunctorum: cornua etiam valde durant; necnon dentes, sicut in ebore, et dentibus equi marini.

8. Pelles etiam et corium valde durant, ut cernere est in pergamenis antiquorum librorum: quinetiam papyrus complura sæcula tolerat, licet pergamenæ duratione cedat.

9. Ignem passa diu durant, ut vitrum, lateres; etiam carnes et fructus, ignem passi, diutius durant quam crudi; neque ob id tantum, quod hujusmodi coctio arceat putredinem, sed etiam quod, emisso humore aqueo, humor oleosus diutius se sustineat.

10. Aqua omnium liquorum citissime sorbetur ab aëre, oleum contra tardius evaporat; ut cernere est non solum in liquoribus ipsis, verum etiam in mistis: etenim papyrus aqua madefacta, atque inde nonnihil diaphaneitatis nacta, paulo post albescit et diaphaneitatem suam deponit, exhalante scilicet vapore aquæ; at contra, papyrus oleo tincta diu diaphaneitatem servat, minime exhalante oleo; unde qui chirographa adulterant, papyrum oleatam autographo imponunt, atque hac industria lineas trahere tentant.

11. Gummi omnia valde diu durant; etiam cera et mel.

12. At æqualitas et inæqualitas eorum quæ corporibus accidunt, non minus quam res ipsæ, ad durationem aut dissolutionem valent. Nam ligna, lapides, alia, vel in aqua vel in aëre perpetuo manentia, plus durant, quam si quandoque alluantur, quandoque afflentur. Atque lapides eruti et in ædificiis positi diutius durant, si eodem situ et ad easdem cœli plagas ponantur quibus jacebant in mineris: id quod plantis etiam e loco motis et alio transplantatis accidit.

Observationes majores.

(1.) Loco *assumpti* ponatur, quod certissimum est; inesse omni tangibili spiritum sive corpus pneumaticum, partibus tangibilibus obtectum et inclusum; atque ex illo spiritu initium capi omnis Dissolutionis et Consumptionis; itaque earundem antidotum est Detentio Spiritus.

(2.) Spiritus detinetur duplici modo; aut per compressionem arctam tanquam in carcere; aut per detentionem tanquam spontaneam. Atque ea mansio etiam duplici ratione invitatur; videlicet, si spiritus ipse non sit mobilis admodum aut acer; atque si insuper ab aëre ambiente minus sollicitetur ad exeundum. Itaque duo sunt Durabilia; Durum, et Oleosum; Durum constringit spiritum; Oleosum partim demulcet spiritum, partim hujusmodi est, ut ab aëre minus sollicitetur: aër enim aquæ consubstantialis, flamma autem oleo. Atque de natura Durabilis et minus Durabilis in Inanimatis, hæc inquisita sint.

Historia.

13. Herbæ quæ habentur ex frigidioribus, annuæ sunt et quotannis moriuntur, tam radice quam caule; ut lactuca, portulaca; etiam triticum, et frumenti omne genus. Sunt tamen etiam ex frigidis, quæ per tres aut quatuor annos durant; ut viola, fragaria, pimpinella, primula veris, acetosa; at borago et buglossa, cum videantur vivæ tam similes, morte differunt; borago enim annua, buglossa anno superstes.

14. At herbæ calidæ plurimæ ætatem et annos ferunt; hyssopus, thymus, satureia, majorana altera[1], melissa, absynthium, chamædrys, salvia, &c. At fœniculum caule moritur, radice

[1] Origanum creticum?

repullulat: ocymum vero, et majorana (quam vocant) suavis[1], non tam ætatis quam hiemis sunt impatientes; satæ enim in loco valde munito et tepido, superstites sunt: certe notum est, schema (qualibus in hortis utuntur ad ornamentum) ex hyssopo, quotannis bis tonsum, usque ad quadraginta annos durasse.

15. Frutices et arbores humiliores, ad sexagesimum annum, aliæ etiam duplo magis, vivunt. Vitis sexagenaria esse potest, et ferax est etiam in senectute. Rosmarinus, fœliciter collocatus, etiam sexagesimum annum complet. At acanthus et hedera ultra centesimum durant. Sed rubi ætas non percipitur, quia flectendo caput in terram novas nanciscitur radices, ut veterem a nova distinguere haud facile sit.

16. Ex arboribus grandioribus annosissimæ sunt quercus, ilex, ornus, ulmus, fagus, castanea, platanus, ficus ruminalis, lotos, oleaster, olea, palma, morus: ex his nonnullæ usque ad octingentesimum annum; etiam earum minus vivaces usque ad ducentesimum perveniunt.[2]

17. At arbores odoratæ et resinosæ, materia sua sive ligno, etiam illis quas diximus magis durabiles; ætate paulo minus vivaces; cupressus, abies, pinus, buxus, juniperus; at cedrus, corporis magnitudine adjutus, etiam superiores fere æquat.

18. Fraxinus, proventu alacris et velox, ætatem ad centesimum annum aut nonnihil ultra producit; quod etiam quandoque facit ferula, et acer, et sorbus; at populus, et tilia, et salix, et (quam appellant) sycomorus, et juglans, non adeo vivaces sunt.

19. Malus, pyrus, prunus, malus Punica, malus Medica, et citria, mespilus, cornus, cerasus, ad quinquagesimum aut sexa-

[1] Origanum majorana? This species was introduced into England from Portugal in 1573, and is biennial. The common sweet basil, which was almost the only kind of ocymum known in England in Bacon's time, is an annual.

[2] Pliny, xvi. 85. and following chapters, appears to have been Bacon's authority with respect to most of the trees here mentioned. The Ficus Ruminalis or Rumina was the sacred fig-tree in the *Comitium* which represented that under which Romulus and Remus were suckled by the wolf. Bacon must have thought that it was some particular kind of fig-tree, and moreover that the Ficus Ruminalis mentioned by classical writers as existing in their time was eadem numero, numerically identical, with its prototype; whereas we are expressly told by Pliny, xv. 20., that it was from time to time renewed—"arescit rursusque cura sacerdotum seritur." Pliny, xvi. 90., speaks of the fig, the apple, and the pomegranate tree as remarkable for the shortness of their duration. See with respect to the Ficus Ruminalis, Ovid, *Fasti*, ii. 411.; Livy, 14.; Plutarch, in *Rom.* 4.; and Tacit. *Annal.* xiii. 53. If, which seems probable from Pliny's statement taken in connexion with the passage in Tacitus, the tree itself furnished the cuttings by planting which its ideal unity was preserved, its continued existence through many centuries is an instance in disproof of the opinion that trees propagated otherwise than by seed die with the stock from which they are taken.

gesimum annum pervenire possunt; præsertim si a musco, nonnullas ipsarum vestiente, aliquando purgentur.

20. Generaliter magnitudo corporis in arboribus cum diuturnitate vitæ (cæteris paribus) nonnihil habet commune; et similiter durities materiæ; quin et arbores glandiferæ et nuciferæ, fructiferis et bacciferis sunt plerunque vivaciores: atque etiam præcocibus vel fructu vel foliis, serotinæ et tardius frondescentes, atque tardius etiam folia deponentes, ætate diuturniores sunt: quin et sylvestres cultis; et in eadem specie, quæ acidum fructum ferunt, illis quæ dulcem.

Observatio Major.

(3.) Bene admodum notavit Aristoteles discrimen inter plantas et animalia, quoad alimentationem et renovationem; quod scilicet corpus animalium suis claustris circumseptum manet; atque insuper, postquam ad justam magnitudinem pervenerit, alimento continuatur et conservatur, sed nihil novum excrescit præter capillos et ungues, quæ pro excrementis habentur; adeo ut necesse sit succos animalium citius veterascere: at in arboribus, quæ novos subinde ramos, nova vimina, novas frondes, novos fructus immittunt, evenit ut et ipsæ quas diximus partes novæ sint, nec ætatem passæ[1]; cum vero quicquid viride sit et adolescens fortius et alacrius alimentum ad se trahat, quam quod incœperit desiccari; evenit una et simul, ut truncus ipse, per quem hujusmodi alimentum transit ad ramos, uberiore et lætiore alimento in transitu irrigetur, perfundatur, et recreetur: id quod etiam insigniter patet ex hoc (licet illud non annotaverit Aristoteles, qui nec ea ipsa quæ jam diximus tam perspicue explicavit), quod in sepibus, sylvis cæduis, arboribus tonsis, amputatio ramorum aut surculorum caulem ipsum aut truncum confortat, illumque efficit longe diuturniorem.

DESICCATIO; DESICCATIONIS PROHIBITIO; ET DESICCATI INTENERATIO.

Historia.

Ad Art. 2. 1. Ignis, et calor intensus, alia desiccat, alia colliquat;

[1] Arist. De Long. et Brevit. Vitæ, c. 6.

Limus ut hic durescit, et hæc ut *cera* liquescit,
Uno eodemque *igne*.[1]

Desiccat terram, et lapides, et lignum, et pannos, et pelles, et quæcunque non fluunt: colliquat metalla, et ceram, et gummi, et butyrum, et sevum, et hujusmodi.

2. Attamen in illis ipsis quæ colliquat ignis, si vehementior fuerit ea in fine desiccat; nam et metalla ex igne fortiore, emisso volatili, minuuntur pondere (præter aurum) et deveniunt magis fragilia; atque oleosa illa et pinguia ab igne fortiore deveniunt frixa, et tosta, et magis sicca, et crustata.

3. Aër, præcipue apertus, manifesto desiccat, nunquam colliquat; veluti cum viæ et superficies terræ, imbribus madefactæ, desiccantur; lintea lota, quæ ad aërem exponuntur, siccantur; herbæ et folia et flores, in umbra siccantur. At multo magis hoc facit aër, si aut solis radiis illustretur (modo non inducat putredinem) aut moveatur; ut flantibus ventis, et in areis perflatilibus.

4. Ætas maxime, sed tamen lentissime, desiccat; ut fit in omnibus corporibus, quæ vetustate (modo non intercipiantur a putredine) arefiunt: ætas autem nihil est per se (cum sit mensura tantum temporis), sed effectus producitur a spiritu corporum innato, qui corporis humorem exugit, et una cum ipso evolat; et ab aëre circumfuso, qui multiplicat se super spiritus innatos et succos corporis, eosque deprædatur.

5. Frigus omnium maxime proprie exiccat; siquidem desiccatio non fit nisi per contractionem; quod est opus proprium frigoris. Quoniam vero nos homines Calidum potentissimum habemus in igne, Frigidum autem infirmum admodum; nihil aliud scilicet quam hiemis, aut fortasse glaciei aut nivis, aut nitri; ideo desiccationes frigoris sunt imbecillæ et facile dissolubiles: videmus tamen desiccari faciem terræ ex gelu, atque ex ventis Martiis, plus quam ex sole; cum idem ventus qui humorem lambit, etiam frigus incutiat.

6. Fumus foci desiccat, ut in laridis, et linguis boum, quæ in caminis suspenduntur: quinetiam suffitus ex olybano[2], aut ligno alöes, et similibus, desiccat cerebrum et catarrhis medetur.

7. Sal, mora paulo longiore, desiccat, non tantum in extimis, sed etiam in profundo; ut fit in carnibus, aut piscibus salitis,

[1] Virg. Ecl. viii. 80.
[2] Boswellia serrata. See the *Asiatic Researches*, ix. p. 377.

quæ per diuturnam salitionem manifesto etiam intrinsecus indurantur.

8. Gummi calidiora, applicata ad cutem, eam desiccant et corrugant; quod faciunt etiam aquæ nonnullæ constringentes.

9. Spiritus vini fortis in tantum desiccat instar ignis, ut et albumen ovi immissum candefaciat, et panem torreat.

10. Pulveres desiccant instar spongiarum, sugendo humidum, ut fit in pulvere atramento injecto post scriptionem; etiam lævor et unio corporis (qui non permittit vaporem humidi ingredi per poros) per accidens desiccat, quia ipsum aëri exponit; ut fit in gemmis, et speculis, et laminis ensium, in quæ si spires, cernuntur illa primo vapore obducta, sed paulo post evanescit ille vapor, ut nubecula. Atque de desiccatione hæc inquisita sint.

11. Granaria in usu sunt hodie ad partes Germaniæ orientales, in cellis subterraneis, in quibus triticum et alia grana conservantur, substrato et circumposito undique stramine ad nonnullam altitudinem, quod humiditatem cavernæ arceat et sorbeat; qua industria servantur grana etiam ad vicesimum aut tricesimum annum; neque servantur tantum a putredine, sed (quod ad præsentem inquisitionem pertinet) in tali viriditate, ut panibus conficiendis optime sufficiant; idemque fuisse in usu in Cappadocia et Thracia et nonnullis locis Hispaniæ perhibetur.[1]

12. Granaria in fastigiis ædium, cum fenestris ad orientem et septentrionem, commode collocantur; quinetiam constituunt quidam duo solaria, superius et inferius; superius autem foraminatum est, ut granum per foramen (tanquam arena in clepsydra) continue descendat, et subinde palis, post aliquot dies, reponatur; ut granum sit in continuo motu. Notandum autem est, etiam hujusmodi res non tantum putredinem cohibere, verum etiam viriditatem conservare et desiccationem retardare; cujus causa est ea quam etiam superius notavimus, quod evolatio humoris aquei, quæ motu et vento acceleratur, humorem oleosum in suo esse conservat; qui alias in consortio humoris aquei fuisset una evolaturus. Etiam in quibusdam montibus, ubi aër est purus, cadavera ad plures dies manent non multum deflorescentia.

[1] Pliny, xviii. 73

13. Fructus, veluti granata, citria, mala, pyra, et hujusmodi; etiam et flores, ut rosa, lilium; in vasis fictilibus bene obturatis diutius servantur; neque tamen non officit aër ambiens ab extimis, qui etiam per vas inæqualitates suas defert et insinuat; ut in calore et frigore manifestum est: itaque si et vasa diligentur obturentur, atque obturata sub terram insuper condantur, optimum erit; neque minus utile est, si non sub terra, sed sub aquis condantur, modo sint umbrosæ, ut putei et cisternæ in domibus; sed quæ sub aquis conduntur, melius reponuntur in vasis vitreis quam in fictilibus.[1]

14. Generaliter, quæ sub terra et in cellis subterraneis aut in profundo aquarum reponuntur, virorem suum diutius tuentur, quam quæ supra terram.

15. Tradunt in conservatoriis nivium (sive sint in montibus in foveis naturalibus, sive per artem in puteis ad hoc factis) observatum fuisse, quod aliquando malum aut castanea aut nux aut simile quippiam inciderit, quæ post plures menses liquefacta nive, aut etiam intra nivem ipsam, inventa sunt recentia et pulchra ac si pridie essent decerpta.

16. Uvæ apud rusticos servantur in racemis coopertis intra farinam; quod licet gustui eas reddat minus gratas, tamen humorem et viriditatem conservat; etiam omnes fructus duriores, non tantum in farina, sed in scobe lignorum, etiam inter acervos granorum integrorum, diu servantur.

17. Invaluit opinio, corpora intra liquores suæ speciei, tanquam menstrua sua, conservari recentia; ut uvas in vino, olivas in oleo, &c.

18. Servantur mala granata et cotonea, tincta paulisper in aquam marinam aut salsam, et paulo post extracta, et in aëre aperto (modo fuerit in umbra) siccata.

19. In vino, oleo, aut amurca suspensa, diu servantur; multo magis in melle, et spiritu vini; atque etiam omnium maxime (ut quidam tradunt) in argento vivo.

20. Incrustatio etiam fructuum cera, pice, gypso, pasta, aut aliis oblinimentis aut capsulis, diutius eos virides conservat.

21. Manifestum est, muscas et araneas et formicas et hujusmodi, casu in electro, aut etiam arborum gummis, immersas et sepultas, nunquam postea marcescere; licet sint corpora mollia et tenera.

[1] See Porta, Natural Magic, iv. 7.

22. Uvæ servantur pensiles; et sic de aliis fructibus; duplex est enim ejus rei commoditas; una, quod absque ulla contusione aut compressione fiat, qualis contra fit cum super dura collocantur; altera, quod aër undequaque ipsas æqualiter ambit.[1]

23. Notatum est, tam putrefactionem quam desiccationem in vegetabilibus non similiter ex omni parte incipere; sed maxime ex ea parte per quam solebant, cum essent viva, attrahere alimentum; itaque jubent aliqui pediculos malorum aut fructuum cera aut pice liquefacta obducere.

24. Fila candelarum aut lampadum majora citius absumunt sevum aut oleum, quam minora; etiam flamma ex gossipio citius quam ex scirpo aut stramine aut vimine ligneo; atque in baculis cereorum, citius ex junipero aut abiete quam ex fraxino: etiam omnis flamma mota et vento agitata citius absumit quam tranquilla; itaque intra cornu minus cito, quam in aperto. Tradunt quoque lychna in sepulchris admodum diu durare.

25. Alimenti etiam natura et præparatio non minus facit ad diuturnitatem lychnorum, quam natura flammæ: nam cera sevo diuturnior est; et sevum paulo madidum, sevo sicciore; et cera dura, cera molliore.

26. Arbores, si quotannis circa radices earum terram moveris, brevius durant; si per lustra aut decennia, diutius; etiam germina et surculos decerpere, facit ad longævitatem; item stercoratio aut substratio cretæ et similium, aut multa irrigatio, feracitati confert, ætatem minuit. Atque de Prohibitione Desiccationis et Consumptionis hæc inquisita sunt.

Inteneratio Desiccati (quæ res est præcipua) experimenta præbet pauca; ideoque nonnulla quæ in animalibus fiunt, atque etiam in homine, conjungemus.

27. Vimina salicis, quibus ad ligandas arbores utuntur, in aqua infusa, fiunt magis flexibilia; similiter virgarum ferulæ extremitates in urceis cum aqua imponuntur, ne siccescant; quin et globuli lusorii, licet per siccitatem rimas collegerint, positi in aqua rursus implentur et consolidantur.

28. Ocreæ ex corio, vetustate duræ et obstinatæ, per illinitionem sevi ad ignem molliuntur; etiam igni simplici admotæ,

[1] Several of these ways of making fruit keep are mentioned in the fourth book of Porta's *Natural Magic*.

nonnihil: vesicæ et membranæ, postquam fuerint induratæ, ab aqua calefacta, admixto sevo aut aliquo pingui, intenerantur; melius autem, si etiam paululum confricentur.

29. Arbores veteres admodum, quæ diu steterunt immotæ, fodiendo et aperiendo terram circa radices ipsarum, manifesto tanquam juvenescunt, novis et teneris frondibus emissis.

30. Boves aratores veteres et laboribus penitus exhausti, in læta pascua inducti, carnibus vestiuntur novis et teneris et juvenilibus, ut etiam ad gustum carnem juvencorum referant.

31. Diæta stricta consumens et emacians, ex guaiaco, pane bis cocto, et similibus, (quali ad curandum morbum Gallicum et inveteratos catarrhos et leucophlegmatiam utimur) homines ad summam macilentiam deducit, consumptis succis corporis; qui, postquam cœperint instaurari et refici, manifesto cernuntur magis juveniles et virides; quinetiam existimamus morbos emaciantes, postea bene curatos, compluribus vitam prolongasse.

Observationes Majores.

1. Miris modis homines, more noctuarum, in tenebris notionum suarum acute vident ad experientiam, tanquam lucem diurnam, nictant et cæcutiunt. Loquuntur de Elementari Qualitate Siccitatis; et de desiccantibus; et de naturalibus periodis corporum, per quas corrumpuntur et consumuntur; sed interim, nec de initiis nec de mediis nec de extremis Desiccationis et Consumptionis aliquid quod valeat observant.

2. Desiccatio et Consumptio, in processu suo, tribus actionibus perficitur; atque originem ducunt actiones illæ a spiritu innato corporum, ut dictum est.

3. Prima actio est, Attenuatio Humidi in Spiritum; secunda est, Exitus aut Evolatio spiritus; tertia est, Contractio partium corporis crassiorum, statim post spiritum emissum; atque hoc ultimum est illa desiccatio et induratio de qua præcipue agimus: priora duo consumunt tantum.

4. De Attenuatione, res manifesta est; spiritus enim, qui in omni corpore tangibili includitur, sui non obliviscitur; sed quicquid nanciscitur in corpore (in quo obsidetur) quod digerere possit et conficere et in se vertere, illud plane alterat et

subigit, et ex eo se multiplicat, et novum spiritum generat. Hoc ex probatione ea, instar omnium, evincitur; quod quæ plurimum siccantur, pondere minuuntur, et deveniunt cava, porosa, et ab intus sonantia; certissimum autem est, spiritum rei præ-inexistentem ad pondus nihil conferre, sed illud levare potius; ergo necesse est, ut spiritus præ-inexistens humidum et succum corporis, quæ antea ponderaverant, in se verterit; quo facto pondus minuitur. Atque hæc est prima actio, scilicet Attenuationis humoris, et conversionis ejus in Spiritum.

5. Secunda actio, quæ est Exitus sive Evolatio spiritus, res etiam manifestissima est. Etenim illa evolatio, cum fit confertim, etiam sensui patet; in vaporibus aspectui, in odoribus olfactui; verum si sensim fiat evolatio, ut fit per ætatem, tum demum peragitur sine sensu; sed eadem res est. Quinetiam ubi corporis compages aut ita arcta est aut ita tenax, ut spiritus poros et meatus non inveniat per quos exeat, tum vero etiam partes ipsas crassiores corporis in nixu suo exeundi ante se agit, easque ultra corporis superficiem extrudit; ut fit in rubigine metallorum, et in carie omnium pinguium. Atque hæc est secunda actio, scilicet Exitus et Evolationis Spiritus.

6. Tertia actio paulo magis obscura, sed æque certa est; ea est contractio partium crassiorum post spiritum emissum. Atque primo videre est corpora post spiritum emissum manifesto arctari, et minorem locum complere; ut fit in nucleis nucium, qui siccati non implent testam; et in trabibus et palis ligni, quæ primo contiguæ sunt ad invicem, ex desiccatione autem hiant; atque ex globulis lusoriis, et similibus, qui per siccitatem rimosi evadunt; cum partes se contrahant, et contractæ necessario spatia inter se relinquant. Secundo patet ex rugis corporum siccatorum; nixus enim se contrahendi tantum valet, ut partes contrahendo interim adducat et sublevet; quæ enim in extremitatibus contrahuntur, in mediis sublevantur; atque hæc cernere est in papyris, et membranis vetustis; atque in cute animalium; atque in extimis casei mollioris; quæ omnia vetustate corrugantur. Atque tertio se ostendit amplius hæc contractio in illis quæ a calore non tantum corrugantur, verum etiam complicantur

et in se vertuntur, et quasi rotulantur; ut cernere est in membranis, et papyris, et foliis ad ignem admotis. Etenim contractio per ætatem, cum tardior sit, rugas fere parit; at contractio per ignem, quæ festina est, etiam complicationes. At in plurimis, ubi non datur corrugatio aut complicatio, fit simplex contractio, et angustiatio, et induratio, et desiccatio, ut primo positum est; quod si eousque invalescat evolatio spiritus et absumptio humidi, ut non relinquatur satis corporis ad se uniendum et contrahendum, tum vero cessat contractio ex necessitate, et corpus redditur putre, et nihil aliud quam pulvisculus cohærens qui levi tactu dissipatur et abit in aërem; ut fit in corporibus cunctis valde absumptis; et papyro et linteo ad ultimum combustis; et cadaveribus imbalsamatis post plura sæcula. Atque hæc est tertia illa actio; scilicet Contractionis partium crassiorum post spiritum emissum.

7. Notandum est ignem et calorem per accidens tantum desiccare; proprium enim eorum opus est, ut spiritum et humida attenuent et dilatent; sequitur autem ex accidente, ut partes reliquæ se contrahant; sive ob fugam vacui tantum, sive ob alium motum simul; de quo nunc non est sermo.

8. Certum est etiam Putrefactionem, non minus quam Arefactionem, a spiritu innato originem ducere, sed longe alia via incedere; nam in Putrefactione spiritus non emittitur simpliciter, sed ex parte detentus mira comminiscitur; atque etiam partes crassiores non tam localiter contrahuntur, quam coëunt singulæ ad homogeniam.

LONGÆVITAS ET BREVITAS VITÆ IN ANIMALIBUS.[1]

Historia.

Ad Art. 3. *Connexio.*

De diuturnitate et brevitate vitæ in animalibus, tenuis est informatio quæ haberi potest; observatio

[1] M. Flourens has recently proposed a new theory with respect to the comparative longevity of different animals. He is of opinion that at least in the class of Mammalia the natural term of life is five times that of growth; and he finds in the junction of the bones with their epiphyses, a phenomenon which marks precise'y the termination of the period of growth. He thus increases the period commonly assigned to growth, and diminishes the factor by which it is to be multiplied in order to give that of the duration of life. In the human species he assigns twenty years to the former

negligens; traditio fabulosa. In cicuribus vita degener corrumpit; in sylvestribus injuria cœli intercipit.

Neque quæ concomitantia videri possint huic informationi multum auxiliantur (moles corporis; tempus gestationis in utero; numerus fœtus; tempus grandescendi; alia); propterea quod complicata sunt ista, atque alias concurrunt, alias disjunguntur.

1. Hominis ævum cæterorum animalium omnium superat (quantum narratione aliqua certa constare potest) præter admodum paucorum. Atque concomitantia in eo satis æqualiter se habent; statura et magnitudo grandis; gestatio in utero novimestris; fœtus ut plurimum unicus; pubes ad annum decimum quartum; grandescentia ad vigesimum.

2. Elephas, fide haud dubia, curriculum humanæ vitæ ordinarium transcendit: gestatio autem in utero decennalis, fabulosa[1]; biennalis, aut saltem supra annuam, certa: at moles ingens, et tempus grandescendi usque ad annum tricesimum; dentes robore firmissimo; neque etiam observationem hominum fugit, quod sanguis elephanti omnium sit frigidissimus; ætas autem ducentesimum annum nonnunquam complevit.

3. Leones vivaces habiti sunt, quod complures ex iis reperti sint edentuli[2]; signo nonnihil fallaci; cum illud fieri possit ex gravitate anhelitus.

4. Ursus magnus dormitor est; animal pigrum, et iners, neque tamen vivacitatis notatum: illud autem signum brevis ævi, quod gestatio ejus in utero sit festina admodum, vix ad quadraginta dies.[3]

5. Vulpi multa se bene habere videntur ad longævitatem; optime tecta est, carnivora, et degit in antris; neque tamen

(agreeing in this with Bacon), and consequently one hundred to the latter period. Of all such speculations it may be said that they are too vague to have much scientific value. A hundred years is neither the average nor the probable duration of human life; nor again is it the extreme limit to which it has occasionally been prolonged. If it be said that it is the age at which men would die but for the effect of accidental diseases, it may be answered that death from mere decay in the strict sense of the word is a phenomenon very seldom observed. When it does occur, it does not appear to take place at any precise age. Again, the existence of a constant numerical ratio in different animals is exceedingly improbable, seeing that all other circumstances of their existence are more or less varied.

[1] Pliny, viii. 10. Flourens is of opinion that the age of the elephant must exceed 150 years, the junction of the bones with their epiphyses being found not to have taken place at thirty.

[2] Aristotle, Hist. An. ix. 44. Flourens assigns twenty years to the full age of the lion.

[3] Aristotle says thirty. Hist. An. vi. 30.

vivacitatis notata: certe est generis canini, quod genus brevioris est vitæ.

6. Camelus longævus est; animal macilentum, et nervosum; ita ut quinquaginta annos ordinario, centum quandoque compleat.[1]

7. Equi vita mediocris, vix quadragesimum annum attingit; ordinarium autem curriculum viginti annorum est[2]: sed hanc brevitatem vitæ fortasse homini debet; desunt enim jam nobis equi Solis, qui in pascuis liberi et læti degebant. Attamen crescit equus usque ad sextum annum, et generat in senectute. Gestat etiam in utero equa diutius quam fœmina, et in gemellis rarior est. Asinus similis fere ævi ut equus; mulus utroque vivacior.

8. Cervorum vita celebratur vulgo ob longitudinem; neque tamen narratione aliqua certa[3]: nescio quid de cervo torquato, cooperta torque ipsa pinguedine carnis, circumferunt.[4] Eo minus credibilis est longævitas in cervo, quod quinto anno perficitur; atque non multo post cornua (quæ annuatim decidunt et renovantur) succedunt magis conjuncta fronte et minus ramosa.

9. Canis brevis est ævi; non extenditur ætas ultra annum vicesimum; neque sæpe attingit ad decimum quartum[5]: animal ex calidissimis, atque inæqualiter vivens; cum, ut plurimum, aut vehementius moveat aut dormiat. Etiam multiparum est, et novem septimanas gestat in utero.

10. Bos quoque, pro magnitudine et robore, admodum brevis est ævi, quasi sexdecim annorum[6]; maresque fœminis nonnihil vivaciores: attamen unicum plerunque edit partum, et gestat in utero circa sex menses. Animal pigrum, et carnosum, et facile pinguescens, et herbis solis pastum.

11. At decennalis ætas in ovibus etiam rara est[7]; licet sit

[1] Arist. Hist. An. vi. 26. and viii. 9. There is apparently some doubt as to the correctness of the text in one or other of the two passages.

[2] Flourens gives twenty-five years as the age of the horse, and quotes from Buffon an apparently well-authenticated case of a horse who lived fifty.

[3] Arist. Hist. An. vi. 29. Aristotle remarks on the improbability of the stag's being long-lived, pointing out the counter-indications afforded by the periods of gestation and growth.

[4] Plin. viii. 50. This story is evidently mythical, and recurs in various forms in the middle ages.

[5] Ten or twelve years is the period assigned by Flourens.

[6] Fifteen or twenty according to Flourens. The error of assigning six months as the time of gestation recurs in the *Sylva Sylvarum*. See also infrà, Observ. Maj. 4.

[7] Plin. viii. 75. According to Pliny and Aristotle, the sheep is somewhat longer-lived than the goat.

animal mediocris magnitudinis, et optime tectum; atque, quod mirum, cum minimum in illis reperiatur bilis, capillitium habent omnium crispissimum; neque enim pilus alicujus animalis tam tortus est, quam lana. Arietes ante tertium annum non generant, atque habiles sunt ad generandum usque ad octavum; fœmellæ pariunt quamdiu vivunt. Morbosum ovis animal, nec ætatis suæ curriculum fere implet.

12. Caper etiam similis est ævi cum ove, nec dispar multum in cæteris; licet sit animal magis agile, et carne paulo firmiore, eoque debuerit esse vivacius; attamen salacius est multo, eoque brevioris ævi.

13. Sues ad quindecim annos quandoque vivunt, etiam ad viginti; cumque sint carne, inter animalia omnia, humidissima, tamen nihil videtur hoc proficere ad longitudinem vitæ. De apro aut sue sylvestri nil certi habetur.

14. Felis ætas est inter sextum annum et decimum; agile animal, et spiritu acri, cujus semen (ut refert Ælianus) fœmellam adurit[1]; unde increbuit opinio, quod felis concipit in dolore, et parit cum facilitate: vorax est in cibis, quos potius deglutit quam mandit.

15. Lepores et cuniculi vix ad septem annos perveniunt[2]; animalia generativa, etiam superfœtantia; in hoc disparia, quod cuniculus sub terra vivit, lepus in aperto; quodque leporis carnes atriores sint.

16. Aves mole corporis quadrupedibus longe sunt minores; pusilla enim res et aquila aut cygnus, præ bove aut equo; item struthio præ elephanto.

17. Aves optime tectæ sunt: pluma enim, tepore et incubitu presso ad corpus, et lanam et capillitia excedit.

18. Aves, cum plures pariant, eos simul in alvo non gestant, sed ova excludunt per vices: unde liberalius sufficit alimentum fœtui.

19. Aves parum aut nihil alimenta mandunt, ut integrum sæpe reperiatur in gulis ipsarum. Attamen frangunt fructuum nuces, et nucleum excerpunt. Existimantur autem esse concoctionis fortis et calidæ.

[1] Ælian. Hist. Animal. vi. 27. Flourens speaks of nine or ten years as the life of the cat.

[2] According to Flourens, the rabbit lives eight years.

20. Motus avium, dum volant, mixtus est inter motum artuum et gestationem; saluberrimum exercitationis genus.

21. De avium generatione Aristoteles bene notavit (sed male ad alia animalia traduxit), minus scilicet conferre semen maris ad generationem; sed activitatem potius indere quam materiam; unde etiam ova fœcunda et sterilia in plurimis non dignoscuntur.[1]

22. Aves quasi omnes ad magnitudinem suam justam perveniunt primo anno, aut paulo post; verum est, quoad plumas in nonnullis, quoad rostrum in aliis, annos numerari; ad magnitudinem autem corporis, minime.

23. Aquila pro longæva habetur; anni non numerantur: etiam in signum trahitur longævitatis, quod rostra renovet, unde juvenescat: ex quo illud *Aquilæ senectus.*[2] Attamen res fortasse ita se habet, ut instauratio aquilæ non mutet rostrum, sed contra mutatio rostri instauret aquilam; postquam enim rostrum aduncitate sua nimium increverit, pascit aquila cum difficultate.

24. Vultures etiam longævi perhibentur, adeo ut vitam fere ad centesimum annum producant: milvi quoque, atque adeo omnes volucres carnivoræ et rapaces, diuturnioris sunt ævi. De accipitre autem, quia vitam degit degenerem et servilem, ex usu humano, minus certum fieri possit judicium circa periodum ejus vitæ naturalem. Attamen ex domesticis, deprehensus est accipiter aliquando ad annos triginta vixisse; ex sylvestribus, ad quadraginta.

25. Corvus traditur esse similiter longævus, aliquando centenarius; carnivora avis, neque admodum frequens in volatu; sed magis sedentaria, et carnibus admodum atris. At cornix, cætera (præterquam magnitudine et voce) similis, paulo minus diu vivit, sed tamen habetur ex vivacibus.

26. Cygnus, pro certo, admodum longævus invenitur, et centesimum annum haud raro superat; avis optime plumata, icthyophaga, et perpetuo in gestatione, idque in aquis currentibus.[3]

27. Anser quoque ex longævis; licet herba et id genus pabulo nutriatur; maxime autem sylvestris; adeo ut in pro-

[1] Arist. De Gen. Anim. ii. 5.; and compare i. 20.

[2] Erasm. Adagia, i. 9. 57.

[3] "Le cygne a l'avantage de jouir jusqu'à un âge extrêmement avancé de sa belle et douce existence."—*Buffon*, quoted by Flourens.

verbium apud Germanos sit, *Magis senex quam anser nivalis.*[1]

28. Ciconiæ longævæ admodum esse deberent si verum esset quod antiquitus notatum fuit, eas Thebas nunquam accessisse, quia urbs illa sæpius capta esset[2]; id si cavissent, aut plusquam unius sæculi memoriam habebant, aut parentes pullos suos historiam edocebant: verum omnia fabellis plena.

29. Nam de phœnice tantum accrevit fabulæ, ut obruatur si qua in ea re fuit veritas. Illud autem quod admirationi erat, eum magno aliarum avium comitatu volantem semper visum, minus mirum; cum hoc etiam in ulula interdiu volante, aut psittaco e cavea emisso, ubique cernere detur.

30. Psittacus, pro certo, usque ad sexaginta annos cognitus est vivere apud nos, quotquot supra habuisset, cum huc esset transvectus.[3] Avis cibi quasi omnigeni, atque etiam mandens cibos, atque mutans subinde rostrum; aspera et ferocula, carnibus atris.

31. Pavo ad viginti annos vivit[4]; oculos autem Argus non recipit ante trimatum: tardigrada avis, carnibus vero candidis.

32. Gallus gallinaceus, salax, pugnax, et brevis ævi: alacris admodum ales, et carnibus etiam albis.

33. Gallus Indicus, aut Turcicus (quem vocant), gallinacei ævum parum superat; iracundus ales, et carnibus valde albis.

34. Palumbes sunt ex vivacioribus, ut quinquagesimum annum aliquando compleant: aërius ales, et in alto et nidificans et sedens. Columbæ vero ac turtures, vita breves, usque ad annum octavum.[5]

35. At phasiani et perdices etiam decimum sextum annum implere possunt. Aves numerosi fœtus, carnibus autem paulo obscurioribus quam pullorum genus.

36. Fertur de merula, quod sit ex avibus minoribus maxime longæva; procax certe avis, et vocalis.

37. Passer notatur esse ævi brevissimi[6]; id quod ad salaci-

[1] "So alt wie eine Schneegans."—*Eiselein's Sprichwörter*, p. 553. Buffon, in the passage just quoted, adopts Willughby's statement, that a goose has been known to live one hundred years.

[2] This story is not told of storks, but of swallows. See Pliny, x. 34.

[3] Fontenelle, as quoted by Flourens, gives a tolerably well authenticated case of a parrot which must have been more than 120 years old.

[4] Aristotle says twenty-five. Hist. Anim. vi. 9.

[5] Arist. Hist. Anim. ix. 7.; who, however, assigns only forty years to the wood-pigeon. Pliny says thirty *or* forty: x. 52.

[6] Arist. ubi suprà.

tatem refertur in maribus: at carduelis, corpore haud major, deprehensus est vivere ad annos viginti.

38. De struthionibus nihil certi habemus; qui domi nutriuntur adeo infœlices fuerunt, ut non deprehensi sint diu vivere: de ave Ibi constat tantum quod sit longæva, anni non numerantur.

39. Piscium vita magis incerta est quam terrestrium, cum sub aquis degentes minus observentur: non respirant ex ipsis plurimi; unde spiritus vitalis magis conclusus est; itaque licet refrigerium excipiant per branchias, haud tamen ita continua fit refrigeratio quam per anhelitum.

40. In aquis cum degant, a desiccatione illa et deprædatione quæ fit per aërem ambientem immunes sunt; neque tamen dubium est, quin aqua ambiens, atque intra poros corporis penetrans et recepta, plus noceat ad vitam quam aër.

41. Sanguinis perhibentur esse minus tepidi; suntque nonnulli ipsorum voracissimi, etiam speciei propriæ; caro autem ipsorum mollior est quam terrestrium, et minus tenax: attamen pinguescunt majorem in modum, ut ex balænis infinita extrahatur quantitas olei.

42. Delphini traduntur vivere annos circa triginta; capto experimento in aliquibus a cauda præcisa: grandescunt autem ad annos decem.[1]

43. Mirum est, quod referunt de piscibus, quod ætate, post annos nonnullos, plurimum attenuantur corpore, manente cauda et capite in magnitudine priore.

44. Deprehensæ sunt aliquando in piscinis Cæsarianis murænæ vixisse ad annum sexagesimum.[2] Certe redditæ sunt longo usu tam familiares, ut Crassus orator unam ex illis defleverit.[3]

45. Lucius, ex piscibus aquæ dulcis, longissime vivere reperitur; ad annum quandoque quadragesimum[4]; piscis vorax, et carnibus siccioribus et firmioribus.

[1] Arist. Hist. Anim. vi. 12.

[2] Pliny, ix 78., on the authority of Seneca. But it is not said that the fish was a muræna.

[3] Plutarch, De Utilitate ex inim. c. 5. A similar story is told of Hortensius. Plin. ix. 81.

[4] "Lucius piscis anno salutis MCCCCXCVII captus est in stagno circa Haylprunn, imperialem Sueviæ urbem; et repertus in eo annulus ex ære Cyprio in branchiis sub cute, modica parte splendere visus; cujus figura et inscriptio fuit qualem exhibemus. Verba Græca circumferentiæ inscripta — εἰμὶ ἐκεῖνος ἰχθὺς ταύτῃ λίμνῃ πωτόπρωτος

46. At carpio, abramus [1], tinca, anguilla, et hujusmodi, non putantur vivere ultra annos decem.

47. Salmones cito grandescunt, brevi vivunt; quod etiam faciunt trutæ; at perca tarde crescit, et vivit diutius.

48. Vasta illa moles balænarum et orcarum quamdiu spiritu regatur, nil certi habemus; neque etiam dephocis, aut porcis marinis, et aliis piscibus innumeris.

49. Crocodili perhibentur esse admodum vivaces, atque grandescendi periodum itidem habere insignem: adeo ut hos solos ex animalibus perpetuo, dum vivunt, grandescere opinio sit.[2] Animal est oviparum, vorax, et sævum, et optime tectum contra aquas. At de reliquo testaceo genere nihil certi, quod ad vitam ipsorum attinet, reperimus.

Observationes majores.

Normam aliquam longævitatis et brevitatis vitæ in animalibus invenire difficile est, propter observationum negligentiam et causarum complicationem. Pauca notabimus.

1. Inveniuntur plures ex avibus longævæ quam ex quadrupedibus (sicut aquila, vultur, milvus, pelicanus, corvus, cornix, cygnus, anser, ciconia, grus, ibis, psittacus, palumbes, &c.), licet intra annum perficiantur, et minoris sint molis. Tegumentum certe ipsarum avium contra intemperies cœli optimum est: cumque in aëre libero plerunque degant, similes sunt habitatoribus montium puriorum, qui longævi sunt. Etiam motus ipsarum, qui (ut alibi dictum est) mixtus est ex gestatione atque motu artuum, minus fatigat aut concutit, et magis salubris est: neque in utero matrum compressionem aut penuriam alimenti patiuntur initia volatilium, quia ova per vices excluduntur: maxime vero omnium illud in causa esse arbitramur, quod fiant aves magis ex substantia

ὑποτεθεὶς διὰ τοῦ κοσμητοῦ Φεδηρίκου β' τὰς χεῖρας ἐν τῇ ἑ ἡμέρᾳ τοῦ Ὀκτοβρίου, κ.τ.λ. —Latine sonant (sicuti Joannes Dalburgus Vuormaciensis episcopus interpretatus est): Ego sum ille piscis huic stagno omnium primus impositus per mundi rectoris Federici secundi manus, die quinto Octobris anno domini MCCXXX. Inde colligitur summa annorum CCLXVII et nimirum antequam a Friderico Augusto ita insigniretur jam aliquandiu vixerat, et si captus non fuisset longiori tempore adhuc vixisset."—*C. Gesner, De Piscibus*, p. 316. ed. 1560.

[1] *Abramus* should be *abramis*; but the error is probably not Bacon's.

[2] Pliny, viii. There are probably very few facts ascertained as to the length of life of reptiles. The Abbé Bonnaterre mentions a green lizard, which was observed for more than twenty years to come out from a hole to enjoy the sunshine. See Dugès, *Annales des Sciences Naturelles*, xvi. p. 366. The longevity of tortoises is well known.

matris, quam patris; unde spiritum nanciscuntur minus acrem et incensum.

2. Poni possit, animalia quæ creantur magis ex substantia matris quam patris esse longæviora; quemadmodum aves, ut dictum est: etiam, quæ longiore tempore gestantur in alvo, plus habere ex substantia matris, minus e semine patris; ac proinde diuturnioris ævi esse: adeo ut existimemus etiam inter homines (quod in aliquibus notavimus) eos qui similiores sunt matribus diutius vivere; nec non liberos senum, qui ex uxoribus adolescentulis progignuntur, modo fuerint patres sani et non morbidi.

3. Initia rerum et injuriæ et auxilio maxime subjiciuntur: itaque minorem compressionem et liberaliorem alimentationem fœtus in utero ad longævitatem multum conferre par est: id fit, aut cum exeunt fœtus per vices, ut in avibus; aut cum pariuntur unici, ut in animalibus uniparis.

4. At tempus longius gestationis in utero tripliciter facit ad longitudinem vitæ. Primo, quod plus habet fœtus ex substantia matris, ut dictum est; deinde, quod prodit confirmatior; postremo, quod aëris vim prædatoriam tardius experitur. Quinetiam denotat periodos ipsius naturæ per majores fieri circulos. Atque licet et boves et oves, qui in utero manent circiter sex menses [1], brevioris sint ævi, tamen id ex aliis causis ortum habet.

5. Comestores graminis et herbæ simplicis, brevis sunt ævi; longioris autem animalia carnivora, aut etiam seminum et fructuum comestores, sicut aves: nam etiam cervi, qui longævi sunt, quasi dimidium pabuli (ut vulgo loquuntur) *supra caput petunt;* anser autem, præter gramen, etiam aliquid invenit ex aquis quod juvet.

6. Integumentum corporis ad longævitatem multum conferre arbitramur: aëris enim inæqualitates (quæ miris modis corpus labefactant et subruunt) propulsat et longius arcet; id quod in avibus præcipue viget. At quod oves, licet bene tectæ sint, parum vivant, id morbis (qui illud animal obsident), atque simplici esui graminis, imputandum est.

[1] This erroneous statement is the more remarkable, as the periods of gestation of the cow and ewe are mentioned by Pliny, who was certainly Bacon's chief authority in matters of natural history. See Plin. viii. 70. 72.

7. Spirituum sedes principalis proculdubio est in capite; atque licet ad animales spiritus tantum hoc vulgo referatur, tamen illud ipsum ad omnia pertinet: neque illud dubium, quod spiritus maxime corpus lambunt et consumunt; adeo ut aut major copia ipsorum, aut major incensio et acrimonia, plurimum vitam abbreviet. Itaque existimamus magnam causam longævitatis in avibus esse, quod pro mole corporis capita habeant tam minuta; adeo ut etiam homines, qui valde magnum habent cranium, minus diu vivere existimemus.

8. Gestationem (ut prius notavimus) omne aliud genus motus ad longitudinem vitæ superare arbitramur; gestantur autem aves aquatiles, ut cygnus; atque aves omnes in volatu, sed cum artuum motu subinde contentiore; et pisces, de quorum vitæ longitudine parum certi sumus.

9. Quæ longiore tempore perficiuntur (non loquendo de grandescentia sola, sed de aliis gradibus ad maturitatem; sicut homo primo emittit dentes, deinde pubem, deinde barbam, &c.) longæviora sunt; indicat enim periodos confici per majores circulos.

10. Animalia mitiora longæva non sunt, ut ovis, columba; bilis enim complurium functionum in corpore veluti cos est et stimulus.

11. Animalia, quorum carnes sunt paulo atriores, longioris sunt vitæ, quam quæ carnibus sunt candidis; indicat enim succum corporis magis firmum et minus dissipabilem.

12. In omni corruptibili quantitas ipsa multum facit ad conservationem integri; etenim ignis magnus longiore tempore extinguitur; aquæ portio parva citius evaporat; truncus non tam cito arescit quam vimen; itaque generaliter (in speciebus dico, non in individuis) quæ mole grandiora sunt animalia, pusillis sunt longæviora; nisi aliqua alia causa potens rem impediat.

ALIMENTATIO ET VIA ALIMENTANDI.

Historia.

Ad Art. 4. 1. Alimentum erga alimentatum debet esse naturæ inferioris, et simplicioris substantiæ. Plantæ ex terra et aqua nutriuntur; animalia ex plantis; homines ex anima-

libus; sunt et animalia carnivora, atque homo ipse plantas sumit in partem alimenti; homo vero et carnivora animalia ex plantis solis ægre nutriuntur; possunt fortasse ex fructibus, et seminibus igne coctis, multo usu nutriri, sed foliis plantarum aut herbarum minime; ut ordo Foliatanorum experimento comprobavit.[1]

2. At nimia proximitas aut consubstantialitas alimenti erga alimentatum non succedit. Etenim animalia quæ herbis vescuntur carnes non tangunt; etiam ex carnivoris animalibus pauca carnes propriæ speciei sapiunt: homines vero qui anthropophagi fuerunt, ordinario tamen humanis carnibus non vescebantur, sed aut ex ultione in inimicos aut pravis consuetudinibus in illud desiderium lapsi sunt: at arvum grano ex ipso proveniente fœliciter non seritur; neque in insitione, surculus aut virgultum in proprium truncum immitti solet.

3. Quo alimentum melius est præparatum et paulo propius accedit ad substantiam alimentati, eo et plantæ feraciores sunt, et animalia habitu sunt pinguiora. Neque enim virgultum aut surculus in terram immissus tam bene pascitur, quam si idem immittatur in truncum cum natura sua bene consentientem, ubi invenit alimentum digestum et præparatum; neque etiam (ut tradunt) semen cepæ, aut similium, in terram immissum, tam magnam producit plantam, quam si semen in aliam cepam indatur, insitione quadam in radicem et subterranea: quinetiam nuper inventum est, virgulta arborum sylvestrium, veluti ulmi, quercus, fraxini, et similium, in truncos insita, longe majora proferre folia, quam quæ sine insitione proveniunt. Etiam homines carnibus crudis non tam bene pascuntur, quam ignem passis.

4. Animalia per os nutriuntur; plantæ per radices; fœtus animalium in utero per umbilicum; aves ad parum temporis ex vitellis ovorum suorum; quorum nonnulla pars, etiam postquam exclusæ sunt, in gulis earum invenitur.

5. Omne alimentum movet maxime a centro ad circumferentiam, sive ab intra ad extra; attamen notandum est, arbores et plantas potius per cortices et extima, quam per medullas et intima, nutriri; etenim si circumcirca decorticatæ fuerint, licet ad spatium parvum, non vivunt amplius: atque sanguis in venis animalium non minus carnes sub illis sitas nutrit, quam supra illas.

[1] See Vol. I. p. 360. note 2.

6. In omni alimentatione duplex est actio, extrusio et attractio; quarum prima a functione interiore, altera ab exteriore procedit.

7. Vegetabilia assimilant alimenta sua simpliciter, absque excretione: etenim gummi et lacrymæ potius exuberantiæ quam excretiones sunt; tuberes autem morbi potius. At animalium substantia magis sui similis est perceptiva; itaque cum fastidio conjuncta est, et inutilia rejicit, utilia assimilat.

8. Mirum est de pediculis fructuum; quod omne alimentum, quod tantos quandoque producit fructus, per tam angusta collula transire cogitur; fructus enim nunquam trunco inhæret, absque pediculo aliquo.

9. Notandum semina animalium nutritionem non excipere, nisi recentia; at semina plantarum manent alimentabilia ad longum tempus: attamen virgulta non germinant, nisi indantur recentia; neque radices ipsæ longius vegetant, nisi sint terra coopertæ.

10. In animalibus gradus sunt nutrimenti pro ætate; fœtui in utero sufficit succus maternus; a nativitate lac; postea cibi et potus; atque sub senectute crassiores fere cibi et sapidiores placent.

Mandatum. Præcipue omnium ad inquisitionem præsentem facit, diligenter et attente indagare, utrum non possit fieri nutritio ab extra; aut saltem non per os? Certe balnea ex lacte exhibentur in marasmis et emaciationibus; neque desunt ex medicis, qui existimant alimentationem nonnullam fieri posse per clysteria: omnino huic rei incumbendum; si enim nutritio fieri possit aut per extra aut alias quam per stomachum, tum vero debilitas concoctionis quæ ingruit in senibus illis auxiliis compensari possit, et tanquam in integrum restitui.

LONGÆVITAS ET BREVITAS VITÆ IN HOMINE.

Historia.

Ad Art. 5, 6, 7, 8, 9, et 11. 1. Ante diluvium, plura centenaria annorum vixisse homines refert Sacra Scriptura: nemo tamen patrum millesimum annum complevit. Neque hæc vitæ diuturnitas gratiæ, aut lineæ sanctæ, attribui possit; cum recenseantur ante diluvium patrum generationes undecim; at

filiorum Adami per Cain tantum generationes octo; ut progenies Cain etiam longævior videri possit.[1] Ista vero longævitas, immediate post diluvium, dimidio corruit; sed in postnatis; nam Noah, qui ante natus erat, majorum ætatem æquavit, et Sem ad sexcentesimum annum pervenit.[2] Deinde, post tres generationes a diluvio, vita hominum ad quartam quasi partem ætatis primitivæ reducta est; videlicet, ad annos circiter ducentos.

2. Abraham annos centum septuaginta quinque vixit[3]: vir magnanimus, et cui cuncta cedebant prospere. Isaac autem ad annum centesimum et octogesimum pervenit[4]; vir castus et vitæ quietioris. At Jacob, post multas ærumnas et numerosam sobolem, ad annum centesimum quadragesimum septimum duravit[5]; vir patiens et lenis et astutus. Ishmael autem, vir militaris, annos centum triginta septem vixit.[6] At Sarah (cujus unicæ ex fœminis anni recensentur) mortua est anno ætatis suæ centesimo vicesimo septimo[7]; mulier decora et magnanima, optima mater et uxor; neque tamen minus libertate, quam obsequio erga maritum, clara. Joseph etiam, vir prudens et politicus, in adolescentia afflictus, postea in magna fœlicitate ætatem transigens, ad annos centum et decem vixit.[8] Levi autem frater ejus, natu major, centesimum tricesimum septimum annum complevit[9]; vir contumeliæ impatiens et vindicativus. Eandemque fere ætatem attigit filius Levi[10]; itemque nepos ejus, pater Aaronis et Mosis.[11]

3. Moses centum viginti annos vixit[12]; vir animosus, et tamen mitissimus, lingua autem impeditus. Ipse vero Moses in psalmo suo vitam hominis pronunciavit annorum tantum septuaginta, et si quis robustior fuerit, octoginta esse; quæ certe mensura vitæ usque ad hodiernum diem maxima ex parte durat. Aaron autem, tribus annis senior, eodem cum fratre anno mortuus est[13]; vir lingua promptior, moribus facilior, et minus constans. At Phineas, Aaronis nepos, (ex gratia fortasse extraordinaria) ad trecentesimum annum vixisse colligitur; si modo bellum Israëlitarum contra tribum Benjamin (in qua expeditione Phineas consultus est) eadem serie temporum gestum

[1] See Genesis, iv. and v. But it does not appear that the children of Lamech were living at the time of the flood.
[2] Gen. xi. 10. and 11.
[3] Gen. xxv. 7.
[4] Gen. xxxv. 28.
[5] Gen. xlvii. 28.
[6] Gen. xxv. 17.
[7] Gen. xxiii. 1.
[8] Gen. l. 26.
[9] Ex. vi. 16.
[10] Ex. vi. 18.
[11] Ex. vi. 20.
[12] Deut. xxxiv. 7.
[13] Numb. xxxiii. 39.

sit, qua res in historia narratur[1]; vir erat omnium maxime zelotes. Joshua autem, vir militaris et dux egregius, et perpetuo florens, ad annum centesimum et decimum vixit.[2] Cui Caleb fuit contemporaneus, et videtur fuisse æquævus. Ehud autem judex, etiam centenarius ad minimum fuisse videtur, cum post devictos Moabitas octoginta annos sub ejus regimine Terra Sancta quievisset[3]; vir acer et intrepidus, quique pro populo se quodammodo devovisset.

4. Job, post instaurationem felicitatis suæ, annos centum et quadraginta vixit[4], cum ante afflictiones suas eorum annorum fuisset, qui filios habuerit ætatis virilis; vir politicus, et eloquens, et euergetes, et exemplum patientiæ. Eli sacerdos vixit annos nonaginta octo[5]; vir corpore obesus, animo placidus, et indulgens in suos. Elizæus autem propheta videtur mortuus esse centenario major[6]; cum reperiatur vixisse post assumptionem Eliæ annos sexaginta; tempore vero assumptionis talis fuerit, ut pueri eum tanquam vetulum calvum subsannaverint: vir vehemens et severus, et austeræ vitæ, et contemptor divitiarum. Isaias etiam propheta videtur esse centenarius; nam prophetiæ munus exercuisse septuaginta annos reperitur[7]; annis, tum quo cœpisset prophetizare, tum quo mortuus esset, incertis: vir admirabilis eloquentiæ, et propheta evangelizans, promissis Dei Testamenti Novi (tanquam uter musto) plenus.

5. Tobias senior annos centum quinquaginta octo; junior centum viginti septem, vixerunt[8]: viri misericordes et eleemosynarii. Videntur etiam tempore captivitatis complures ex Judæis qui e Babylone reversi sunt longævi fuisse; cum utriusque Templi (interjecto annorum septuaginta spatio) dicantur meminisse, et disparitatem ipsorum deplorasse.[9] Postea defluxis sæculis compluribus, tempore Servatoris, Simeon invenitur nonagenarius[10]: vir religiosus, et spei et expectationis

[1] Joseph Scaliger, *Elench. Orat. Chron.* p. 65., affirms that Phineas cannot have been less than three hundred and forty years of age when the event took place, related Judges, xx. 28.; observing that the Phineas there spoken of is not to be confounded with the person of the same name mentioned 1 Chron. ix. 20.; an error which Scaliger says almost every one has committed.

[2] Josh. xxiv. 29. [3] Judges, iii. 30. [4] Job, xlii. 16. [5] 1 Sam. iv. 15.

[6] Elijah's assumption is referred to the year B.C. 887. The death of Elisha took place somewhere after 832. Vide *L'Art de verifier les Dates.*

[7] Isaiah began to prophesy B.C. 751, and was put to death according to a constant tradition by Manasses, who began to reign in 694. If we suppose that this took place in the thirteenth year of Manasses, we get the seventy years mentioned in the text. *L'Art de verifier les Dates.*

[8] Tobit, xiv. 11. and 14. [9] Ezra, iii. 12.

[10] Very little appears to be known of the person here mentioned; and the attempt

plenus. Et eodem tempore Anna prophetissa ultra centenarium vixisse manifesto deprehenditur; cum septem annis nupta fuisset, vidua autem per annos octoginta quatuor[1], quibus addendi sunt anni virginitatis, et qui prophetiam ejus de Servatore insecuti sunt: mulier sancta, et vitam degens in orationibus et jejuniis.

6. Longævitates hominum qui apud ethnicos authores inveniuntur, parum certæ memoriæ sunt; tum propter fabulas, in quas hujusmodi narrationes proclives admodum sunt, tum propter fallaciam in calculationibus annorum. Certe de Ægyptiis nil magni refertur in his quæ extant, quoad longævitatem; cum reges ipsorum qui longissime regnarunt, quinquagesimum aut quinquagesimum quintum annum non excesserint; quod pro nihilo est, cum etiam temporibus modernis hujusmodi spatia nonnunquam compleantur. At Arcadum regibus vitæ longissimæ fabulose tribuuntur[2]: regio certe illa montana, et pastoralis, et victus incorrupti; attamen cum sub Pane tanquam deo tutelari fuerit, videntur etiam omnia quæ ad eam pertinent fuisse tanquam Panica, et vana, et ad fabulas idonea.

7. Numa Romanorum rex octogenarius fuit[3]; vir pacificus et speculativus, et religioni addictus. M. Valerius Corvinus centum annos implevit[4], interjectis inter primum et sextum consulatum annis quadraginta sex; vir bello et animis fortissimus, ingenio civilis et popularis, et fortuna perpetuo florens.

8. Solon Atheniensis, legislator, et unus ex Septem, supra annos octoginta vixit[5]; vir magnanimus, sed popularis, et amans patriæ; item eruditus, et non alienus a voluptatibus et vita teneriore. Epimenides Cretensis centum quinquaginta septem annos vixisse traditur; mixta res cum portento, quia quinquaginta septem ipsorum sub antro eum delituisse ferunt.[6] At dimidio sæculi post, Xenophanes Colophonius annos centum et duos, aut etiam diutius vixit; utpote qui viginti quinque annos natus patriam reliquit, septuaginta septem totos annos est peregrinatus, ac postea rediit[7]; sed quamdiu a reditu vixerit, non

made to identify him with the Simeon spoken of by Josephus does not appear to rest on any good foundation.

[1] St. Luke, ii. 36. and 37. [2] Pliny, vii. 49. [3] Lucian, Macrobii, 8.
[4] Pliny, ubi suprà. [5] Diog. Laert. i. 62. [6] Pliny, ubi suprà.
[7] See Diog. Laertius, ix. 19. But septuaginta ought to be sexaginta, as Xenophanes says in the lines to which Bacon alludes: —

ἤδη δ' ἑπτά τ' ἔασι καὶ ἑξήκοντ' ἐνιαυτοὶ
βλητριζοντες ἐμὴν φροντίδ' ἀν' Ἑλλάδα γῆν.
ἐκ γενέτης δὲ τότ' ἦσαν ἐείκοσι πέντε τε πρὸς τοῖς.

constat: vir non magis itineribus quam mente oberrans; utpote cujus nomen, propter opiniones, a Xenophane in Xenomanem traductum est[1]; vasti proculdubio conceptus, et nihil spirans nisi infinitum.

9. Anacreon poëta major octogenario fuit[2]; homo lascivus, et voluptuarius, et bibax. Pindarus Thebanus octogesimum annum complevit[3]; poëta sublimis, cum quadam novitate ingenii, et multus in cultu deorum. Sophocles Atheniensis similem ætatem complevit[4]; poëta grandiloquus, totus in scribendo, et familiæ negligens.

10. Artaxerxes Persarum rex annos nonaginta quatuor vixit[5]; vir hebetioris ingenii, neque curarum magnarum patiens, amans gloriæ, sed otii magis. Eodem tempore Agesilaus rex Spartanus octoginta quatuor annos implevit[6]; vir moderatus, ut inter reges philosophus; sed nihilominus ambitiosus et bellator, et tam militia quam rebus gerendis strenuus.

11. Gorgias Leontinus annos centum et octo vixit[7]; vir rhetor, et prudentiæ suæ ostentator, et qui adolescentes mercede accepta ut institueret, multum peregrinator fuit, et paulo ante mortem, *nihil se habere quod senectutem incusaret*, dixit.[8] Protagoras Abderites nonaginta annos vixit[9]: iste similiter rhetor fuit, sed non tam cyclopædia usus, quam civiles res et instructionem ad rempublicam tractandam docere professus; attamen circumcursator civitatum æque ac Gorgias. At Isocrates Atheniensis nonagesimum octavum annum complevit[10];

[1] I do not know by whom Xenophanes is called Xenomanes: not, I believe, by any ancient writer. The name was probably suggested by a wrong reading in Simplicius on Aristotle *De Cælo*. Simplicius in speaking of Xenophanes is made to say, ἀγνοῶ δὲ τοῖς τοῦ φιλοξένου ῥήμασι τοῖς περὶ τούτων οὐκ ἐντυχών, κ.τ.λ., where, as Brandis observes, τοῦ φιλοξένου ought to be τοῦ φιλοσόφου Ξενοφάνους. (See Karsten's *Xenophanis Reliquiæ*, p. 30.) Some one not perceiving this, imagined that Simplicius meant to say that Xenophanes was a lover of novelties, and therefore thought himself justified in calling him Xenomanes.

[2] Luc. Macrob. 26.

[3] According to Suidas, he died at the age of fifty-five. But Fabricius shows that if, as Suidas says, he was forty at the time of the battle of Salamis, he must have been more than ninety when he died. See Fab. *Biblioth. Græc.* ii. 14.

[4] Lucian, Macrob. 34., says that he died aged ninety-five years.

[5] Lucian, Macrob. 15.; who mentions that, according to another account, Artaxerxes was only eighty-six years old when he died.

[6] Plut. in Agesil. p. 618.

[7] Pliny, vii. 49.; Diog. Laert., viii. 58., says a hundred and nine.

[8] Cicero, De Senect. 5.—*J. S.*

[9] Diog. Laert. ix. 55.; who mentions that Apollodorus affirms that he was only seventy when he died.

[10] Luc. Macrob. 23. So too Dion. Halicar., who however says that he was born in the fifth year before the beginning of the Peloponnesian war. His birth cannot therefore be put earlier than 436 B.C.; and as he died at the time of the battle of Chæronea, 339 B.C., he could not have completed his ninety-eighth year.

rhetor item, sed vir valde modestus, et lucem forensem fugiens, atque domi tantum scholam aperiens. Democritus Abderites ad annos centum et novem ætatem produxit[1]; magnus philosophus, et, si quis alius ex Græcis, vere physicus; regionum complurium, et multo magis naturæ ipsius, perambulator; sedulus quoque experimentator, et (quod Aristoteles ei objicit[2]) similitudinum potius sectator, quam disputationum leges servans. Diogenes Synopeus ad nonaginta annos vixit[3]; vir erga alios liber, in se imperiosus; victu sordido et patientia gaudens. Zeno Cittieus centenarius, duobus tantum demptis annis, fuit[4]; vir animo excelso, et opinionum contemptor, magni itidem acuminis, neque tamen molesti, sed quod animos magis caperet quam constringeret; quale etiam postea fuit in Seneca. Plato Atheniensis annum octogesimum primum implevit[5]; vir magnanimus, sed tamen quietis amantior, contemplatione sublimis et imaginativus, moribus urbanus et elegans; attamen magis placidus quam hilaris, et majestatem quandam præ se ferens. Theophrastus Etesius annum octogesimum quintum complevit[6]; vir dulcis eloquio, dulcis etiam rerum varietate; quique ex philosophia suavia tantum decerpserit, molesta et amara non attigerit. Carneades Cyrenæus, multis postea annis, ad octogesimum quintum ætatis annum similiter pervenit[7]; vir eloquentiæ profluentis, quique grata et amœna cognitionis varietate et seipsum et alios delectaret. At Ciceronis tempore Orbilius, non philosophus aut rhetor, sed grammaticus, ad centesimum fere annum vixit[8]; primo miles, deinde ludimagister; vir natura acerbus et lingua et calamo, et versus discipulos etiam plagosus.

12. Q. Fabius Maximus sexaginta tribus annis Augur fuit[9]; unde constat eum octogenario majorem occubuisse; licet verum sit in Auguratu nobilitatem magis spectari solitam, quam ætatem: vir prudens et cunctator, et in omnibus vitæ partibus moderatus, et cum comitate severus. Masinissa rex Numidarum nonagesimum annum superavit, et filium genuit post octogesimum quintum[10]; vir acer, et fortunæ fidens, et juventute multas rerum vicissitudines expertus, decursu ætatis constanter fœlix. At M. Porcius Cato ultra annum nonagesimum vixit[11]; vir ferrei prope

[1] Diog. Laert. ix. 43.
[2] See Vol. I. p. 666. note 2.
[3] Diog. Laert. vi. 76.
[4] Id. vii. 28.
[5] Luc. Macrob. 21.; Diog. Laert. iii. 2.
[6] Diog. Laert. v. 40.
[7] Id. iv. 65.; Luc. Macrob. 20.
[8] Suetonius, De illustr. Grammat. c. 9.
[9] Pliny, vii. 49.
[10] Valerius Maximus, *De Gratis.*
[11] Not more than eighty-five. Compare Cicero, *De Senect.* 10., and *De Amic.* 3.

corporis et animi; linguæ acerbæ, et simultates amans; idem agriculturæ deditus, sibique et familiæ suæ medicus.

13. Terentia Ciceronis uxor ad annum centesimum tertium vixit[1]; mulier multis ærumnis conflictata, primo exilio mariti, deinde dissidio, et rursus calamitate ejus extrema; etiam podagra sæpius vexata. Luceia annum centenarium haud parum superavit[2]; cum dicatur centum annis totis in scena mimam agens pronuntiasse; puellæ fortasse primo partes suscipiens, postremo anus decrepitæ. At Galeria Copiola, mima etiam et saltria, pro tyrocinio suo producta est in scenam, quoto anno ætatis incertum est; verum post annos nonaginta novem ab ea productione rursus reducta est in scenam, non jam pro mima sed pro miraculo, in dedicatione theatri a Pompeio Magno; neque hic finis, cum etiam in ludis votivis pro salute divi Augusti iterum monstrata sit in scena.[3]

14. Fuit et alia mima, ætate paulo inferior, dignitate sublimior, quæ ad nonagesimum annum ætatem fere produxit; Livia Julia Augusta, Cæsaris Augusti uxor, Tiberii mater.[4] Etenim si fabula fuit vita Augusti (id quod ipse voluit, cum decumbens amicis præcepisset, ut postquam expirarit, sibi *Plaudite* exhiberent), certe et Livia optima mima fuit; quæ cum marito obsequio, cum filio potestate quadam et prædominantia, tam bene congrueret: mulier comis, et tamen matronalis, negotiosa, et potestatis tenax. At Junia C. Cassii uxor, M. Bruti soror, etiam nonagenaria fuit; cum post aciem Philippensem sexaginta quatuor annos vixisset.[5] Mulier magnanima, opibus fœlix, calamitate mariti et proximorum et longa viduitate mœsta, sed tamen honorata.

15. Memorabilis est annus Domini septuagesimus sextus, tempore imperatoris Vespasiani, quo reperiuntur longævitatis tanquam fasti[6]; eo enim anno peractus est census (census

[1] Pliny, vii. 49. [2] Id. ib.

[3] This story is incorrectly told. I quote Pliny's words: "Galeria Copiola Emboliaria reducta est in scenam, Cn. Pompeio Q. Sulpitio coss. ludis pro salute Divi Augusti votivis, annum centesimum quartum agens: quæ producta fuerat tyrocinio a M. Pomponio Ædili plebis, Calo Mario Cn. Carbone consulibus, ante annos nonaginta novem: et a Magno Pompeio magni theatri dedicatione anus pro miraculo reducta." The interval of ninety-nine years was between her first and last appearance, not as Bacon supposes between her first and second. Moreover Hardouin substitutes *nonaginta unum* for *nonaginta novem*, so that she was thirteen in the consulship of Marius and Carbo, whereas the text of Dalechamp, which I have followed as it seems that Bacon used it, would make her only five when she first appeared on the stage. Also Cn. Pompeio ought to be C. Poppæo.

[4] She died aged eighty-six. See Dio Cassius, p. 621. It appears from Pliny, xiv. 8, that she must have been more than eighty-three.

[5] Tacitus, Annals, iii. 76. [6] See Pliny, vii. 5.

autem de ætatibus auctoritatem et informationem habet fidissimam); atque in ea parte Italiæ quæ jacet inter Apenninum et Padum, inventi sunt homines, qui annum centesimum æquarunt et superarunt, centum et viginti quatuor; videlicet annorum centum, homines quinquaginta quatuor; annorum centum et decem, homines quinquaginta septem[1]; annorum centum et viginti quinque, homines duo; annorum centum et triginta, homines quatuor; annorum centum et triginta quinque aut triginta septem, homines item quatuor; annorum centum et quadraginta, homines tres. Præter hos, speciatim Parma edidit quinque, quorum tres centum viginti annos, duo centum triginta compleverunt; Bruxella[2] unum annorum centum viginti quinque; Placentia unum annorum centum triginta unius; Faventia unam mulierem annorum centum triginta duorum; oppidum quoddam (tunc dictum Velleiacium) in collibus circa Placentiam decem dedit, quorum sex annum ætatis centesimum decimum, quatuor centesimum vicesimum compleverunt[3]; Ariminum denique unum centum et quinquaginta annorum, nomine M. Aponium.

Monitum. Ne res in longum procederet, visum est tam in illis quos jam recensuimus, quam in his quos mox recensebimus, nullam adducere octogenario minorem. Apposuimus autem singulis characterem sive elogium verum et perbreve; at ejusmodi quod judicio nostro nonnullam habeat ad longævitatem (quæ moribus et fortuna non parum regitur) relationem; sed duplici modo: aut quod tales longævi esse plerunque soleant, aut quod tales, licet minus apte dispositi, tamen longævi esse aliquando possint.

16. Inter imperatores Romanos et Græcos, item Francos et Germanos, usque ad nostram ætatem, qui numerum prope ducentorum principum complerunt, quatuor tantum inventi sunt octogenarii; quibus addere liceat imperatores duos primos, Augustum et Tiberium[4]; quorum hic septuagesimum octavum, ille septuagesimum sextum annum implevit; et ad octogesimum forte pervenire uterque potuisset, si placuisset Liviæ et Caio. Augustus (ut dictum est) annos vixit septuaginta sex; vir moderatus ingenio, idem ad res perficiendas

[1] Bacon follows Dalechamp's reading. Hardouin's is xiv.
[2] This is a mere mistake for Brixillum.
[3] Beside these there was one person at Velleiacum one hundred and forty years of age.
[4] Suetonius in August. 100. and in Tiber. 73.

vehemens, cætera placidus et serenus, cibo et potu sobrius, venere intemperantior, per omnia fœlix; quique anno ætatis tricesimo gravem et periculosum passus est morbum, adeo ut salus ejus pro desperata esset: quem Antonius Musa medicus, cum cæteri medici calida medicamenta tanquam morbo convenientia adhibuissent, contraria ratione frigidis curavit[1]; quod fortasse ei ad diuturnitatem vitæ profuit. Tiberius duos amplius annos vixit; vir *lentis maxillis* (ut Augustus aiebat[2]), sermone scilicet tardus, sed validus; sanguinarius, bibax, quique libidinem etiam in diætam transtulit; attamen valetudinis suæ curator probus, ut qui solitus esset dicere, stultum esse qui post triginta annorum vitam medicum consuleret aut advocaret. Gordianus senior octoginta annos vixit, et tamen violenta morte periit[3], postquam vix degustasset imperium; vir magnanimus et splendidus, eruditus et poëta, et constanti vitæ tenore (ante ipsum obitum) fœlix. Valerianus imperator septuaginta sex annos vixit, antequam a Sapore rege Persarum captus esset; post captivitatem autem septem annos vixit inter contumelias; etiam violenta morte præreptus[4]; vir mediocris animi, nec strenuus; existimatione tamen paulo eminentior et evectus, experimento minor. Anastasius cognomine Dicorus octoginta octo annos vixit[5]; homo animi sedati, sed humilior, et superstitiosus, et timidus. Anicius Justinianus annos octoginta tres vixit[6]; vir gloriæ appetens, persona propria socors, ducum suorum virtute fœlix et celebris; uxorius, neque suus, sed aliorum ductu circumactus. Helena Britanna, Constantini Magni mater, octogenaria fuit[7]; mulier civilibus rebus minus se immiscens, nec mariti nec filii imperio, sed tota religioni dedita; magnanima et semper florens. Theodora imperatrix (quæ Zoes soror erat, Monomachi uxoris, ipsa autem post obitum ejus sola regnavit) annos supra octoginta vixit[8]; mulier negotiosa, et imperio delectata, fœlix admodum et ex fœlicitate credula.

[1] Sueton. in August. 81.

[2] Id. in Tiber. 21.

[3] He was born A. D. 157, and died A. D. 237.

[4] It is difficult to fix the chronology of Valerian's life. Tillemont's opinion is that he was seventy when he was taken. I do not know on what authority Bacon speaks of a seven years' captivity. One account appears to show that he was a prisoner for nine years, but this account makes him only sixty-one at the time of his overthrow. Tillemont admits that the words of Trebellius Pollio seem to indicate that Valerian was seventy when he became emperor. If so, he was about seventy-six when he was taken prisoner. See Tillemont, *Vies des Empereurs*, in Valerian.

[5] Born about A. D. 430, died 518.

[6] Scarcely so much; he was born A. D. 483, and died in 565.

[7] Born A. D. 247, and died A. D. 327.

[8] This seems to be incorrect It is said that Theodora's elder sister Zoe was forty-

17. Jam a secularibus ad principes viros in ecclesia narrationem convertemus. S. Johannes, Apostolus Servatoris et discipulus amatus, nonaginta tres annos vixit[1]: vere aquilæ emblemate notatus, nihil spirans nisi divinum, et tanquam Seraph inter Apostolos propter fervorem charitatis. S. Lucas evangelista octoginta quatuor annos complevit[2]; vir eloquens et peregrinator, S. Pauli comes individuus, et medicus. Symeon Cleophæ, frater Domini dictus, episcopus Hierosolymitanus, annos centum et viginti vixit[3], licet martyrio præreptus fuerit: vir animosus, et constans, et bonorum operum plenus. Polycarpus Apostolorum discipulus, Smyrnensis episcopus, videtur ad centum annos et amplius ætatem produxisse, licet martyrio interceptus[4]; vir excelsi animi et heroicæ patientiæ, et laboribus indefessus. Dionysius Areopagita, Paulo Apostolo contemporaneus, ad nonaginta annos vixisse videtur[5]; *Volucris Cœli* appellatus ob theologiam sublimem; neque minus factis quam meditationibus insignis. Aquila et Priscilla, Pauli Apostoli primo hospites, deinde coadjutores, conjugio fœlici et celebri ad centum ad minimum annos vixerunt[6]; cum sub Xisto primo superstites fuerint; nobile par, et in omnem charitatem effusum; quibus inter maximas consolationes (quales proculdubio primos illos ecclesiæ fundatores sequebantur), etiam illud conjugalis consortii tanquam magnus cumulus accesserat. S. Paulus Eremita annos centum et tredecim vixit[7];

eight when she married Romanus Argyrus in 1028. Theodora died in 1056, and must therefore have been less than seventy-six at the time of her death. See the *Biographie Universelle* in Zoe, and Gibbon, ix. p. 48.

[1] The age at which St. John died is not well ascertained, but Bacon's statement agrees with Baronius's. See Baron. ii. p. 12. Tholuck, in the introduction to his *Commentary on St. John's Gospel*, mentions that St. John, according to St. Jerome, died at the age of one hundred, and according to Suidas of one hundred and twenty years.

[2] According to Nicephorus, St. Luke was eighty when he died. Baron. i. p. 586.

[3] Euseb. Hist. iii. 29.

[4] Polycarp at his martyrdom said that he had been a servant of Christ for eighty-six years. This is probably the ground upon which Bacon's estimate of his age is founded. Euseb. Hist. iv. 15.

[5] He was twenty-five at the time of the Crucifixion, was converted nineteen years afterwards, and ordained three years after his conversion. See Baronius, anno LII. Now Syncellus, in his *Life of Dionysius*, says that he preached for seventy years; so that if these statements be correct, he must have been a hundred and seventeen when he died.

[6] Nothing certain is known of the deaths of Priscilla and Aquila. In the *Menologium Græcorum*, Feb. 13., it is said that after the death of Paul they were persecuted and ultimately beheaded; which seems to imply that they did not very long survive him. It is possible that Aquila, the husband of Priscilla, has been confounded with the person of the same name who lived in the time of Hadrian, and who was therefore contemporary with Sistus I.

[7] See his life by St. Jerome.

vixit autem in spelunca, victu tam simplici et duro, ut eo vitam tolerare supra humanas vires videri possit; in meditationibus et soliloquiis tantummodo ævum transigens: qui tamen non illiteratus, aut idiota, sed eruditus fuit. S. Antonius, Cœnobitarum primus institutor, aut (ut alii volunt) restitutor, ad centesimum quintum annum pervenit[1]: vir devotus et contemplativus, et tamen civilibus rebus utilis; vitæ genere austero et aspero; attamen in gloriosa quadam solitudine degens, nec sine imperio; cum et monachos suos sub se habuisset, atque insuper a compluribus et Christianis et philosophis, veluti vivum aliquod simulacrum, non sine adoratione quadam visitatus esset. S. Athanasius mortuus est octogenario major[2]; vir invincibilis constantiæ, famæ semper imperans, nec fortunæ succumbens; idem erga potentiores liber, erga populum gratiosus et acceptus; exercitatus contentionibus, in iisque et animosus et solers. S. Hieronymus plurimorum consensu annum nonagesimum superavit[3]; vir calamo potens, et virilis eloquentiæ; varie eruditus, et linguis et scientiis; peregrinator item, atque vitæ versus senium austerioris; sed in vita privata spiritus gerens altos, et late fulgens ex obscuro.

18. At Papæ Romani numerantur ducenti quadraginta unus; ex tanto numero quinque solummodo octogenarii aut supra reperiuntur[4]; primitivis autem compluribus justa ætas martyrii

[1] S. Athanas. Vita S. Anton. c. 89

[2] Born A.D. 296; died 372.

[3] According to some authorities he was born in 340. He died in 420, so that he was about 80 at the time of his death, if this statement as to that of his birth is correct. Bacon has adopted the statement that St. Jerome was born in 331, which rests, I believe, on the authority of Prosper Aquitanicus.

[4] The twenty-third of the opuscula of Peter Damiani is entitled "De brevitate vitæ pontificum Romanorum et providentiâ Divinâ." It was written in reply to a question put to him by Alexander II.—why popes live so short a time after their elevation. Damiani's solution is that Providencedesigns to show the transitoriness of all human greatness. It was a common notion that no successor of St. Peter could occupy the pontifical chair as long as he did, namely for 25 years. "Non videbis annos Petri" was a sort of popular prophecy. However, of those who lived before the time of Bacon at least four popes beside those mentioned in the text attained the age of eighty, viz. Celestin III., Gregory IX., Benedict XIII. (Pedro de Luna), and Calistus III. Of these the second is said to have been nearly a hundred. Benedict XIII., if he is to be accounted a true pope, is especially remarkable for having been pope thirty years. See *L'Art de verifier les Dates.* Haller's remarks on the length of life of the popes deserve notice. His principal authority appears to be Lancesius; from whom he has also quoted the statement that a third part of the sacred college are — I presume he means ordinarily — eighty years of age or upwards. "Sobrii Itali; accurati potissimum in vitæ ratione et Pontifices; iidem longævi; et ut fortius sit argumentum, Itali medio ævo parum legibus sobrietatis tenebantur, et eo tempore et Cardinales et ipsi Pontifices ante diem extinguebantur, ut cum plurimi trigesimo vitæ anno, et etiam juniores, ad thiaram pervenirent, nullus eorum 24 annis eo decore gavisus sit, quos bis nunc superarent si ea ætate thronum considere daretur."—*Vita humana et Mors*, sec. ii. § 18.; *Physiol.* t. viii. pars 2. p. 113.

prærogativa anticipata est. Joannes vicesimus tertius, Papa Romanus, nonagesimum ætatis annum complevit[1]; vir ingenii inquieti, et novis rebus studens, et multa transferens, nonnulla in melius, haud pauca in aliud; magnus autem opum et thesauri accumulator. Gregorius dictus duodecimus, creatus Papa in schismate, et quasi interrex, nonagenarius obiit[2]; de eo propter brevitatem papatus nihil invenimus, quod annotemus. Paulus tertius ad octoginta et unum annos vixit[3]; vir sedati animi et profundi consilii, idem doctus et astrologus, et valetudinem impense regens; more autem veteris sacerdotis Eli, indulgens in suos. Paulus quartus octoginta tres annos vixit[4]; vir natura asper et severus, altos gerens spiritus, et imperiosus, ingenio commotior, sermone eloquens et expeditus. Gregorius decimus tertius similem ætatem octoginta trium annorum implevit[5]; vir plane bonus, animo et corpore sanus, politicus, temperatus, euergetes et eleemosynarius.

19. Quæ sequentur, ordine promiscua, fidei magis dubiæ, observatione magis jejuna, erunt. Rex Arganthonius, qui regnavit Gadibus in Hispania, centum et triginta, aut (ut alii volunt) quadraginta, annos vixit; ex quibus octoginta regnavit[6]; de moribus ejus et vitæ genere, et tempore quo vixit, siletur. Cinyras Cypriorum rex in insula illa, tunc habita beata et voluptuaria, centum quinquaginta aut sexaginta annos vixisse perhibetur.[7] Reges duo Latini in Italia, pater et filius, alter octingentos, alter sexcentos annos, vixisse traduntur[8]; ve-

[1] Bacon evidently intends to speak of John XXII., who died in 1334, in the ninetieth year of his age. The age at which John XXIII. died is not mentioned, so far as I know, by any one. It was by John XXII. that the first fruits of all benefices were made payable into the papal chancery. To this and similar enactments Bacon alludes in saying that he was "magnus opum et thesauri accumulator." See Platina, Vite dei Pont. iii. 208.

[2] He died, according to the *Biographie Universelle*, aged 92.

[3] See Platina, Vite dei Pontifice, iv. 66.

[4] Ib. iv. 101. [5] Ib. iv. 159.

[6] Cicero, Herodotus, and Valerius Maximus agree in saying that Arganthonius lived a hundred and twenty years, and Pliny seems inclined to agree with them. He mentions however that Anacreon affirms that he lived to be a hundred and fifty. According to one account he died at a hundred and thirty. That he reigned eighty years is said by Cicero and Pliny. See Cicero *De Senect.* [19], Herodotus [i. 163], Val. Max. viii. 13., and Pliny, vii. 49.

[7] Pliny on the authority of Anacreon, ubi suprà.

[8] This story is related by Valerius Maximus and Pliny. "Xenophon in periplo, maritimorum regem ccccc, atque ut parcè mentitus filium ejus dccc, quæ omnia inscitiâ temporis acciderunt."—*Pliny*, ubi suprà. For *maritimorum* Hardouin has *Thyniorum*, and in the parallel passage in Val. Maximus there are three readings, *Lachmiarum*, *Lamorum*, and *maritimorum*. The reading *Latinorum* Bacon probably took from Dalechamp's margin, where it is mentioned with one or two others.

rum hoc narratur a philologis quibusdam, quibus et ipsis (cætera satis credulis) fides rei suspecta est, imo damnata. Arcadum reges nonnullos trecentos annos vixisse alii tradunt[1]; regio certe ad vitam longam satis idonea; res fortasse fabulis aucta. Narrant Dandonem quendam in Illyrico absque incommodis senectutis quingentos annos vixisse.[2] Apud Epios, Ætoliæ videlicet partem, narrant universam gentem admodum longævam fuisse; ut multi ex his ducenûm annorum inventi sint; inter eos præcipuum quendam nomine Litorium, virum giganteæ staturæ, qui trecentos annos cumulaverat.[3] In Tmoli montis fastigio (*Tempsi* antiquitus vocato) homines complures centum quinquaginta annos vixisse traditur.[4] Sectam Essæorum apud Judæos ultra centum annos communiter vixisse tradunt[5]; secta autem illa simplici admodum diæta utebatur, ad regulam Pythagoræ. Apollonius Tyanæus centum annos excessit[6], aspectu (ut in tanta ætate) pulcher; vir certe mirificus, apud ethnicos divinus habitus, apud Christianos magus; victu Pythagoricus, magnus peregrinator, magna etiam gloria florens, et tanquam pro numine cultus; attamen sub finem ætatis accusationes et contumelias passus, unde nihilominus incolumis quoquo modo evasit. Attamen ne longævitas sua diætæ Pythagoricæ solum tribuatur, sed etiam e genere suo aliquid traxisse videatur, avus ejus etiam centum triginta annos vixit.[7] Q. Metellum ultra centum annos vixisse certa res est[8]; atque, post consularia imperia fœliciter administrata, pontificem maximum jam senem creatum esse, et sacra per viginti duos annos tractasse; neque ore in votis nuncupandis hæsitante, neque in sacrificiis faciendis tremula manu gerentem.[9] Appium Cæcum annosissimum fuisse constat; annos non numerant[10]; quorum partem majorem postquam luminibus orbatus esset transegit; neque propterea mollitus, familiam numerosam, clientelas quamplurimas, quinetiam rempublicam fortissime rexit; extrema vero ætate lectica in senatum delatus, pacem

[1] Pliny, vii. 49.
[2] Pliny, ubi suprà.
[3] Valerius Max. xiii. 6. Pliny, ubi suprà, calls him Pictoreum.
[4] Pliny, ubi suprà.
[5] Joseph. De Bello Judaic. ii.
[6] Philostratus in the life of Apollonius of Tyana, c. 13., mentions several statements of the age at which he died. That in the text is the largest of those which he has given. Fabric. *Bibl. Græc.* iv. 24. is inclined to fix Apollonius's age at ninety-six.
[7] No mention is made anywhere of Apollonius's grandfather. He is here confounded with the grandfather of Iarchas. See the preface, p. 95.
[8] Valerius Maximus, viii. 13.
[9] So in original, and also in ed. 1638. Blackbourn silently substituted *utentem* for *gerentem*. — *J. S.*
[10] Val. Max. ubi suprà.

cum Pyrrho vehementissime dissuasit; cujus principium orationis admodum memorabile, et invincibile quoddam robur et impetum animi spirans. *Magna*, inquit, *impatientia* (*Patres Conscripti*) *cæcitatem meam per plures jam annos tuli; at nunc etiam me surdum quoque optaverim, cum vos tam deformia consilia agitare audiam.*[1] M. Perpenna vixit annos nonaginta octo; omnibus quos consul sententiam in senatu rogaverat (hoc est, omnibus senatoribus sui anni) superstes fuit; etiam omnibus quos paulo post censor in senatum legerat, septem tantum exceptis.[2] Hiero, rex Siciliæ temporibus belli Punici secundi, ad centesimum fere annum vixit[3]: vir et regimine et moribus moderatus; numinum cultor, et amicitiæ conservator religiosus; beneficus, et constanter fortunatus. Statilia, ex nobili familia, Claudii tempore, vixit annos nonaginta novem.[4] Clodia Ofilii filia centum et quindecim.[5] Xenophilus, antiquus philosophus e secta Pythagoræ, centum et sex annos vixit[6], sana et vivida senectute, et magna apud vulgum doctrinæ fama. Insulani Corcyrei habebantur olim vivaces, sed hodie communi aliorum sorte vivunt.[7] Hippocrates Cous, medicus insignis, centum et quatuor annos vixit[8]; artemque suam tam longa vita comprobavit et honestavit: vir cum prudentia quadam doctus; in experientia et observatione multus; non verba aut methodos captans, sed nervos tantum scientiæ separans et proponens. Demonax philosophus (non solum professione, sed moribus) tempore Adriani, ad centenarium fere annum vixit[9]: vir magni animi, atque animi victor, idque vere sine affectatione, et in maximo humanarum rerum contemptu civilis et urbanus. Is cum amici de sepultura ipsius verba injicerent, *Desinite*, inquit, *de sepultura curare; cadaver enim fœtor sepeliet.* Atque illi, *Placet ergo avibus aut canibus exponi?* Ille rursus, *Cum*, inquit, *vivus hominibus prodesse pro viribus contenderim, quæ invidia est si mortuus etiam animalibus aliquid præbeam?* Populus Indiæ, Pandoræ appellati, admodum longævi; etiam usque ad annum ducentesimum[10]: addunt rem magis miram;

[1] Plutarch, i. 394.
[2] Pliny, vii. 49.
[3] Val. Max., viii. 13., says that he died in his ninetieth year.
[4] Pliny, ubi suprà.
[5] Id. ib.
[6] More than a hundred and five years, is the statement in the *Macrobii*, c. 18.
[7] Corcyrei is doubtless a mistake for Corsi. The longevity of the Corsi is mentioned by Athenæus, ii. p. 47.
[8] According to one account he was a hundred and nine at the time of his death.
[9] Lucian, Demonax, 66., from whom the circumstances which Bacon goes on to mention are derived.
[10] Pliny, vii. 2.

scilicet cum pueri fere candido capillo fuerint, senectute ante canitiem eos nigrescere solitos: id tamen ubique vulgare est, ut pueris capillitio candidiore virili ætate pili mutentur in obscurius. Etiam Seres, Indorum populus, cum vino suo ex palmis, longævi habiti sunt, usque ad annum centesimum tricesimum.[1] Euphranor grammaticus consenuit in schola, et docebat literas ultra annum centesimum.[2] Ovidius senior, poëtæ pater, nonaginta annos vixit[3]; diversus a moribus filii, utpote qui Musas contempsit, et poëticem filio dissuasit. Asinius Pollio, Augusti familiaris, centum annos superavit[4]: vir ingentis luxus, eloquens, literarum cultor; attamen vehemens, superbus, crudelis, et tanquam sibi natus. Invaluit opinio de Seneca, quod admodum annosus fuerit, usque ad annum centesimum decimum quartum[5]; quod verum esse non potest, cum tantum absit ut senex decrepitus ad Neronis tyrocinium admotus sit, ut contra rebus gerendis strenue suffecerit; quinetiam paulo ante, medio tempore Claudii, exularit, ob adulteria aliquarum principum fœminarum; quod in talem ætatem non competit. Joannes de Temporibus, ex omnibus posterioribus sæculis, traditione quadam et opinione vulgari, usque ad miraculum, vel potius usque ad fabulam, longævus perhibetur, annorum supra trecentos[6]: natione fuit Francus, militavit autem sub Carolo Magno. Gartius Aretinus, Petrarchæ proavus, ad centum et quatuor annos pervenit[7],

[1] "Onesicritus, quibus in locis Indiæ umbræ non sint, corpora hominum cubitorum quinum et binorum palmorum existere et vivere annos centum et triginta," &c.—*Pliny*, vii. 2. As the longevity of the Seres is mentioned in the preceding sentence, I believe that this is the passage which Bacon was thinking of, though we cannot account for his speaking of palm wine except by supposing that he was misled by a hasty glance at the phrase "binorum palmorum." Lucian in the *Macrobii* expressly says that the Seres were said to be a nation of water-drinkers. Palm wine was however, Pliny elsewhere says, common throughout the East.

[2] Suidas in v. Apion.

[3] Ovid, Tristia, iv. 10. 77.

[4] Bacon manifestly confounds Asinius Pollio with Pollio Romilius, of whom Pliny says, "Centesimum annum excedentem eum D. Augustus hospes interrogavit quânam maxime ratione vigorem illum animi corporisque custodisset. At ille respondit, Intus mulso, foris oleo."—*Pliny*, xxii. 53. Asinius Pollio died, according to Eusebius, *Chron.* Olymp. 195, at the age of eighty. Moreri makes him eighty-four.

[5] The notion that the philosopher Seneca lived to a great age arose from confounding him with his father the rhetorician. Raphael Volaterranus (*Comment. Urban.* p. 223.) is said to be the first writer by whom they are distinguished. See Antonius, *Bibl. Vet. Hisp.* i. 4. 47. A hundred and eight years intervene between the death of Cicero and that of the younger Seneca. Now in the preface to the first book of *Controversiæ* Marcus Seneca says that he was old enough to have heard Cicero, though the civil war prevented his doing so. Between his birth therefore and his son's death there can scarcely be less than a hundred and twenty years. Compare Cardan, Paralipomena, xlv. 8.

[6] His name is said to have been Jean de Stampis (D'Estampes), and the change to Johannes de Temporibus is connected with his mythical longevity. See Zuingerus, *Theatrum vitæ humanæ*, or Fulgosius, *Factorum dictorumque memorabilium*, p. 298.

[7] See Petrarch, *Rerum memorandarum*, § De Senectute; or Fulgosius, ubi modo.

prospera semper usus valetudine, atque in extremis vires labantes sentiens potius quam morbum; quæ vera est resolutio per senium. Ex Venetis reperiuntur haud pauci longævi, etiam gradu eminentiori; Franciscus Donatus dux; Thomas Contarenus procurator S. Marci; Franciscus Molinus item procurator S. Marci[1]; alii. At maxime memorabile est illud de Cornaro Veneto, qui corpore sub initio valetudinario, cœpit primum metiri cibum et potum ad certum pondus, in curam sanitatis: ea cura transiit usu in diætam, et ex diæta in magnam longævitatem, usque ad annum centesimum et ultra[2], integris sensibus, et constanti valetudine. Gulielmus Postellus, nostra ætate, Gallus, ad centesimum et prope vicesimum annum vixit[3]; etiam summitatibus barbæ in labro superiore nonnihil nigrescentibus, neque prorsus canis: vir capite motus, et non integræ omnino phantasiæ; magnus peregrinator, et mathematicus, et hæretica pravitate nonnihil aspersus.

20. Apud nos in Anglia, arbitror non existere villulam paulo populosiorem, in qua non reperiatur aliquis vir aut mulier ex octogenariis; etiam ante paucos annos, in agro Herefordiensi, inter ludos florales, instituta erat chorea et saltatio ex viris octo, quorum ætas simul computata octingentos annos complebat; cum quod alteris eorum ad centenarium deesset, alteris aliquibus superesset.

21. In hospitali Bethleem, ad suburbia Londini, quod in sustentationem et custodiam phreneticorum institutum est, inveniuntur de tempore in tempus multi ex mente captis fuisse longævi.

22. Ætates, de quibus fabulantur, nympharum et dæmonum aëreorum, qui corpore mortales essent sed admodum longævi (id quod et antiqua et inter quosdam recenti superstitione et credulitate receptum est[4]) pro fabulis et somniis habemus;

[1] These three persons are mentioned by Egnatius, *Exempla illustr. Venetor.* The longevity of the Venetians is noticed by Peter Ravennas.

[2] "Cornaro mourut le 26 Avril, 1566. Je n'ai pu trouver la date précise de sa naissance. La *Biographie Universelle* le fait naître en 1467. . . . . La *Notice* écrite par sa nièce, dit positivement *cent ans*, une autre *Notice* dit *plus de cent ans*, une troisième dit *cent cinq.*" — *Flourens, De la Longevité*, p. 33.

[3] Postellus died in 1583, being then, according to the biographical dictionaries, more than seventy-one. Bacon's statement is altogether incorrect. It is not improbable that Postel may have chosen to represent himself as much older than he really was. He was a man of great learning, but on some subjects scarcely sane: "quem insania ab omnis malitiæ suspicione vindicare poterit" is Joseph Scaliger's judgment of him See Morhof. Polyhistor. i. 4. 5.

[4] Bacon probably alludes to the Rosicrucians who began to be talked of in the early part of the 17th century.

præsertim cum sit res nec cum philosophia nec cum religione bene consentiens.

Atque de historia Longævitatis in Homine, per individua aut individuis proxima, hæc inquisita sint. Jam ad observationes per capita transibimus.

23. Decursus sæculorum et successio propaginis nihil videntur omnino demere de diuturnitate vitæ; quippe curriculum humanæ ætatis videmus usque a tempore Mosis ad nostra circa octogesimum annum stetisse; neque sensim et paulatim (ut quis crederet) declinasse. Sunt certe tempora in singulis regionibus, quibus homines diutius aut brevius degunt. Diutius plerunque, cum tempora fuerint barbara, et simplicioris victus, et exercitationi corporis magis dedita; brevius, cum magis civilia, et plus luxuriæ et otii: verum ista transeunt per vices, propago ipsa nihil facit. Neque dubium est quin idem fiat in animalibus cæteris; siquidem nec boves nec equi aut oves, et similia, ævo ultimis his sæculis minuuntur; itaque præcipitatio ætatis facta est per Diluvium; et fieri fortasse potest per similes majores casus (ut loquuntur), veluti inundationes particulares, combustiones per longas siccitates, terræ motus, et similia. Quinetiam videtur similis esse ratio in magnitudine corporum, sive statura; quæ nec ipsa per successionem propaginis defluit; licet Virgilius (communem opinionem secutus) divinasset posteros futuros præsentibus minores; unde ait de campis Æmathiis et Æmonensibus[1] subarandis:

Grandiaque effossis mirabitur ossa sepulchris.[2]

Etenim cum constet fuisse quondam homines staturis giganteis (quales et in Sicilia et alibi, in vetustis sepulchris et cavernis, pro certo reperti sunt), tamen jam per tria fere millenaria annorum, ad quæ producitur memoria satis certa, in iisdem locis nil tale continuatur; licet etiam hæc res per mores et consuetudines civiles vices quasdam patiatur, quemadmodum et illa altera. Atque hæc magis notanda, quia insedit animis hominum penitus opinio quod sit perpetuus defluxus per ætatem, tum quoad diuturnitatem vitæ tum quoad magnitudinem et robur corporis; omniaque labi et ruere in deterius.[3]

24. Regionibus frigidioribus et hyperboreis diutius homines vivunt plerunque, quam calidioribus; quod necesse est fieri,

[1] Æmoniis. [2] Virg. Georg. i. 497.

[3] Pliny, vii. 17. "Mundo senescente consenescunt homines," remarks Roger Bacon; who adopted the opinion from which his namesake here dissents.

cum et cutis sit magis astricta, et succi corporis minus dissipabiles; et spiritus ipsi minus acres ad consumendum, et magis fabriles ad reparandum; et aër (utpote modice calefactus a radiis solis) minus prædatorius. At sub linea æquinoctiali, ubi sol transit, et duplex sit hiems et æstas, sitque etiam major æqualitas inter spatia dierum et noctium (si cætera non impediant), etiam bene diu vivunt; ut in Peruvia et Taprobana.[1]

25. Insulani mediterraneis ut plurimum sunt longæviores; neque enim tam diu vivunt in Russia, quam in Orcadibus; neque tam diu in Africa ejusdem paralleli, quam in Canariis et Terceris; Japonenses etiam Chinensibus (licet hi longævitatis appetentes sint usque ad insaniam) sunt vivaciores; nec mirum, cum aura maris et in regionibus frigidioribus foveat et in calidioribus refrigeret.

26. Loca excelsa potius edunt longævos, quam depressa; præsertim si non sint juga montium, sed terræ altæ quatenus ad situm eorum generalem; qualis fuit Arcadia in Græcia, et Ætoliæ pars, ubi longævi admodum fuerunt. At de montibus ipsis eadem foret ratio, propter aërem videlicet puriorem et limpidiorem, nisi hoc labefactaretur per accidens; interventu scilicet vaporum ex vallibus eo ascendentium, et ibi acquiescentium. Itaque in montibus nivalibus non reperitur aliqua insignis vitæ longitudo; non in Alpibus, non in Pyrenæis, non in Apennino; sed medii colles, aut etiam valles, dant homines longæviores. At in montium jugis protensis versus Æthiopiam et Abyssinos, ubi, propter arenas subjectas, parum aut nihil incumbit in montes vaporis, diutissime vivunt, etiam ad hodiernum diem; annum non raro centesimum et quinquagesimum implentes.

27. Paludes et tractus earum, præsertim exporrecti in plano, nativis propitii, advenis maligni, quoad vitæ prorogationem aut decurtationem; quodque mirum videri possit, paludes aqua salsa per vices inundatæ, minus salubres quam quæ aqua dulci.

28. Regiones particulares, quæ notatæ sunt longævos produxisse, sunt Arcadia, Ætolia, India cis Gangem, Brasilia, Taprobana, Britannia, Hybernia, cum Insulis Orcadibus et Hebridibus; nam de Æthiopia quod ab aliquo ex antiquis refertur, quod longævi fuerint, res vana est.[2]

[1] Pliny, vii. 2.

[2] It is difficult to know why Bacon rejects this statement, as it rests on the same authority as that of the longevity of the Seres, and as it seems to accord with what he himself asserts in paragraph 26. See Pliny ubi suprà, and compare Herod. iii. 23.

29. Occulta est res salubritas, præsertim perfectior, aëris; et potius experimento quam discursu et conjectura elicitur. Capi possit experimentum ex vellere lanæ, per expositionem in aërem cum mora aliqua dierum, minus aucto pondere: aliud ex frusto carnis diutius manente non putrefacto; aliud ex vitro calendari minori spatio reciprocante. De his et similibus amplius inquiratur.

30. Aëris non tantum bonitas aut puritas, verum etiam æqualitas, quoad longævitatem spectatur. Collium et vallium varietas, aspectui et sensui grata, longævitati suspecta; at planities modice sicca, nec tamen nimis sterilis aut arenosa, nec prorsus sine arboribus et umbra, diuturnitati vitæ magis commoda.

31. Inæqualitas aëris (ut jam dictum est) in loco mansionis mala; verum mutatio aëris in peregrinatione, postquam quis assueverit, bona; unde et magni peregrinatores longævi fuere: similiter etiam longævi, qui in tuguriolis suis, eodem loco, perpetuo vitam degerunt; aër enim assuetus minus consumit, at mutatus magis alit et reparat.

32. Ut series et numerus successionum ad diuturnitatem aut brevitatem vitæ nihil est (ut jam diximus), ita conditio immediata parentum, tam ex parte patris quam matris, proculdubio multum potest. Alii siquidem generantur ex senibus, alii ex adolescentulis, alii ex viris ætate justiore; item alii a patribus cum sani fuerint et bene dispositi; alii a morbidis et languidis; item alii a repletis et ebriis, alii post somnum et horis matutinis; item alii post longam intermissionem veneris, alii post venerem repetitam; item alii flagrante amore patrum (ut fit plerunque in spuriis), alii defervescente, ut in conjugiis diuturnis. Eadem etiam ex parte matris spectantur: quibus addi debent, conditio matris dum gestat uterum, quali sanitate, quali diæta; et tempus gestationis, ad decimum mensem, aut celerius. Hæc ad normam reducere, quatenus ad longævitatem, difficile est; atque eo difficilius, quod fortasse quæ optima quis putaret in contrarium cedent. Etenim alacritas illa in generatione quæ liberos corpore robustos et agiles producit, ad longævitatem minus utilis erit, propter acrimoniam et incensionem spirituum. Diximus antea, plus habere ex materno sanguine, conferre ad longævitatem; etiam mediocria simili ratione optima esse putamus; amorem potius conjugalem quam meretricium; horas generationis matutinas; statum corporis non nimis alacrem aut

turgidum, et similia. Illud etiam bene observari debet, quod habitus parentum robustior ipsis magis est propitius, quam fœtui; præcipue in matre: itaque satis imperite Plato existimavit claudicare virtutem generationum, quod mulieres similibus cum viris exercitiis, tam animi quam corporis, non utantur[1]; illud contra se habet: distantia enim virtutis inter marem et fœminam maxime utilis est fœtui; atque fœminæ teneriores magis præbitoriæ sunt ad alendum fœtum; quod etiam in nutricibus tenet. Neque enim Spartanæ mulieres, quæ ante annum vicesimum secundum, aut (ut alii dicunt) quintum, nubere non solebant (ideoque Andromanæ[2] vocabantur) generosiorem aut longæviorem sobolem ediderunt, quam Romanæ aut Athenienses aut Thebanæ, apud quas anni duodecim aut quatuordecim nubiles erant. Atque si in Spartanis aliquid fuerit egregium, id magis victus parsimoniæ debebatur, quam nuptiis mulierum serotinis. Illud vero experientia docet, esse quasdam stirpes ad tempus longævas; ut longævitas sit, quemadmodum morbi, res hæreditaria, in aliquibus periodis.

33. Candidiores genis, cute, et capillis, minus vivaces; subnigri, aut rufi, aut lentiginosi, magis. Etiam rubor nimius in juventute longævitatem minus promittit, quam pallor. Cutis durior longævitatis signum potius, quam mollior; neque tamen hoc intelligitur de cute spissiori (quam vocant *anserinam*) quæ est tanquam spongiosa; sed de dura simul et compacta; quin et frons majoribus rugis sulcatus, melius signum, quam nitidus et explicatus.

34. Pili in capite asperiores, et magis setosi, ostendunt vitam longiorem, quam molles et delicati; crispi vero eandem prænuntiant, si sint simul asperi; contra si sint molles et splendentes. Item si sit crispatio potius densa, quam per largiores cincinnos.

35. Citius aut serius calvescere, res est quasi indifferens; cum calvastri plurimi longævi fuerint; etiam cito canescere (utcunque videatur canities præcursor ingruentis senectutis) res fallax est; cum haud pauci præpropere canescentes, diu postea vixerint: quinetiam præmatura canities, absque ulla calvitie, signum est longævitatis; contra, si concomitetur calvities.

36. Pilositas partium superiorum signum vitæ minus longæ;

[1] See the fifth book of the *Republic* [§ 3.].

[2] See for this name Plutarch, *Comp. Lycurg. cum Numâ*, i. p. 77. But it is not expressly connected with the lateness of marriage.

atque pectore hirsuti, et quasi jubati, minus vivaces: at inferiorum pilositas, ut femorum, tibiarum, signum longæ vitæ.

37. Proceritas staturæ (nisi fuerit enormis) compage commoda, et sine gracilitate, præsertim si concomitetur corporis agilitas, signum longæ vitæ; at contra, homines brevioris staturæ magis vivaces, si fuerint minus agiles et motu tardiores.

38. In corporis analogia; qui corpore aliquanto breviores sunt, tibiis longioribus, longæviores sunt, quam qui corpore magis demisso, tibiis autem brevioribus: item, qui inferioribus partibus largiores sunt et superioribus contractiores (structura corporis quasi surgente in acutum), longæviores, quam qui humeros lati, deorsum sunt tanquam attenuati.

39. Macies cum affectibus sedatis, tranquillis, et facilibus; pinguior autem habitus cum cholera, vehementia, et pertinacia; diuturnitatem vitæ significant; obesitas autem in juventute breviorem vitam præmonstrat, in senectute res est magis indifferens.

40. Diu et sensim grandescere, signum vitæ longæ; si ad staturam magnam, magnum signum; sin ad minorem, signum tamen: at contra velociter grandescere ad staturam magnam, signum malum est; sin ad staturam brevem, minus malum.

41. Carnes firmiores, et corpus musculosum et nervosum, et nates minus tumentes (quantum sedendo tantum sufficiant), et venæ paulo eminentiores, longævitatem denotant: contraria brevitatem vitæ.

42. Caput, pro analogia corporis, minutius; collum mediocre, non oblongum, aut gracile, aut tumidum, aut tanquam humeris impactum; nares patulæ, quacunque forma nasi; os largius; auris cartilaginea, non carnosa; dentes robusti et contigui, non exiles, aut rari; longævitatem prænuntiant; et multo magis, si dentes aliqui novi provectiore ætate proveniant.

43. Pectus latius, sed non elevatum, quin potius adductius; humerique aliquantulum gibbi, et (ut loquuntur) fornicati; venter planus, nec prominens; manus largior, et palma minus lineis exarata; pes brevior et rotundior; femora minus carnosa; suræ non cadentes, sed se altius sustentantes; signa longævitatis.

44. Oculi paulo grandiores, atque iris ipsorum cum quodam virore; sensus omnes non nimis acuti; pulsus juventute tardior, sub ætatem vergentem paulo incitatior; detentio anhelitus

facilior et in plura momenta; alvus juventute siccior, vergente ætate humidior, signa etiam longævitatis.

45. De temporibus nativitatis nihil observatum est, quoad longævitatem, memoratu dignum, præter astrologica, quæ in topicis relegavimus. Partus octimestris, non solum pro non vivaci, verum etiam pro non vitali habetur; etiam partus hiemales habentur pro longævioribus.

46. Victus sive diæta Pythagorica, aut monastica, secundum regulas strictiores, aut ad amussim æqualis (qualis fuit illa Cornari), videtur potenter facere ad vitæ longitudinem. At contra, ex iis qui libere et communi more vivunt, longæviores reperti sunt sæpenumero edaces et epulones, denique qui liberaliore mensa usi sunt. Media diæta, quæ habetur pro temperata, laudatur, et ad sanitatem confert, ad vitam longævam parum potest; etenim diæta illa strictior spiritus progignit paucos et lentos, unde minus consumit; at illa plenior alimentum præbet copiosum, unde magis reparat; media neutrum præstat: ubi enim extrema nociva sunt, medium optimum; verum ubi extrema juvativa, medium nihili fere est. Diætæ autem illi strictiori convenit etiam vigilia, ne spiritus pauci multo somno opprimantur; exercitatio item modica, ne exolvantur; veneris abstinentia, ne exhauriantur; at diætæ uberiori convenit contra somnus largior, exercitatio frequentior, usus veneris tempestivus. Balnea et unguenta (qualia fuerunt in usu) deliciis potius, quam vitæ producendæ, accommodata fuerunt. Verum de his omnibus, cum ad inquisitionem secundum intentiones ventum erit, accuratius dicemus. Illud interim Celsi, medici non solum docti, verum etiam prudentis, non contemnendum est; qui varietatem et alternationem diætæ jubet, sed cum inclinatione in partem benigniorem[1]; scilicet, ut quis vigiliis quandoque se assuescat, alias somno indulgeat, sed somno sæpius; itidem interdum jejunet, interdum epuletur, sed epuletur sæpius; interdum animi contentionibus strenue incumbat, interdum remissionibus utatur, sed remissionibus sæpius. Illud certe minime dubium est, quin diæta bene instituta partes ad prolongandam vitam potiores teneat; neque conveni unquam aliquem valde longævum, qui interrogatus de victu suo non observasset aliquid peculiare; alii alia. Equidem memini quendam senem centenario majorem, qui productus est testis

[1] See Celsus, i. 1.

de antiqua quadam præscriptione; is cum, finito testimonio, a judice familiariter interrogaretur, quid agens tam diu vixisset; respondit (præter expectatum, et cum risu audientium) *Edendo antequam esurirem, et potando antequam sitirem.* Sed de his (ut dictum est) postea.

47. Vita religiosa et in sacris videtur ad longævitatem facere.[1] Sunt in hoc genere vitæ, otium; admiratio et contemplatio rerum divinarum; gaudia non sensualia; spes nobiles; metus salubres; mœrores dulces; denique renovationes continuæ per observantias, pœnitentias, et expiationes; quæ omnia ad diuturnitatem vitæ potenter faciunt. Quibus si accedat diæta illa austera, quæ massam corporis induret, spiritus humiliet, nil mirum si sequatur longævitas insignis; qualis fuit Pauli eremitæ, Symeonis Stylitæ anachoretæ columnaris, et complurium aliorum monachorum ex eremo et anachoretarum.

48. Huic proxima est vita in literis, philosophorum, rhetorum, et grammaticorum. Degitur hic quoque in otio, et in iis cogitationibus quæ, cum ad negotia vitæ nihil pertineant, non mordent, sed varietate et impertinentia delectant; vivunt etiam ad arbitrium suum, in quibus maxime placeat horas et tempus terentes; atque in consortio plerunque adolescentium, quod paulo lætius est. In philosophiis autem magna est discrepantia, quoad longævitatem, inter sectas. Etenim philosophiæ, quæ nonnihil habent ex superstitione et contemplationibus sublimibus, optimæ; ut Pythagorica, Platonica: etiam quæ mundi perambulationem et rerum naturalium varietatem complectebantur, et cogitationes habebant discinctas et altas et magnanimas (de infinito, et de astris, et de virtutibus heroicis et hujusmodi) ad longævitatem bonæ; quales fuerunt Democriti, Philolai, Xenophanis, Astrologorum, et Stoicorum: etiam quæ nihil habebant speculationis profundioris, sed ex sensu communi et opinionibus vulgatis, absque inquisitione acriori, in omnem partem placide disputabant, similiter bonæ; quales ferunt Carneadis et Academicorum; item rhetorum et grammaticorum. At contra, philosophiæ in subtilitatum molestiis versantes, et pronuntiativæ, et singula ad principiorum trutinam examinantes et torquentes, denique spinosiores et angustiores, malæ; quales fuerunt plerunque Peripateticorum et Scholasticorum.

[1] "Comment tant de gravité et tant de vieillesse disait, il y a peu de jours, un évêque François au doyen des curés de son diocèse. Caritas, Castitas, Sobrietas, Pietas, repondit celui-ci."—*Marcellus, Episodes Littéraires.*

49. Vita rusticana item ad longævitatem idonea; frequens est sub dio et aëre libero; non socors, sed in motu; dapibus plerunque recentibus et inemptis; sine curis et invidia.

50. De vita militari, in juventute, etiam bonam habemus opinionem; certe complures bellatores egregii longævi fuerunt; Corvinus, Camillus, Xenophon, Agesilaus [1], et alii tam prisci quam moderni: prodest certe longævitati, si a juventute ad ætatem provectam omnia crescant in benignius, ut juventus laboriosa dulcedinem quandam senectuti largiatur; existimamus etiam affectus militares, ad contentionis studium et spem victoriæ erectos, talem infundere calorem spiritibus, qui longævitati prosit.

MEDICINÆ AD LONGÆVITATEM.

Ad Art. 10. *Commercio.*

Medicina quæ habetur, intuetur fere tantum conservationem sanitatis et curationem morborum; de iis autem quæ proprie spectant ad longævitatem, parva est mentio et tanquam obiter. Proponemus tamen ea medicamenta quæ in hoc genere notantur, *cordialia* scilicet quæ vocantur. Etenim quæ, sumpta in curationibus, cor et (quod verius est) spiritus muniunt et roborant contra venena et morbos, translata cum judicio et delectu in diætam, etiam ad vitam producendam aliqua ex parte prodesse posse consentaneum est. Id faciemus non promiscue ea cumulantes (ut moris est), sed excerpentes optima.

1. Aurum triplici forma exhibetur [2]; aut in auro (quod appellant) potabili; aut in vino extinctionis auri; aut in auro in substantia, qualia sunt aurum foliatum et limatura auri. Quod ad Aurum Potabile attinet, cœpit dari in morbis desperatis aut gravioribus pro egregio cordiali, atque successu non contemnendo. Verum existimamus spiritus salis, per quos fit dissolutio, virtutem illam quæ reperitur largiri, potius quam

[1] Corvinus and Agesilaus have been already mentioned: for Xenophon see the *Macrobii*, where he is said to have reached the age of ninety. It is impossible to fix the age at which Camillus died. His death took place B. C. 365, thirty-eight years after his first consular tribuneship.

[2] "Utendi ratio est cum vel candens jusculis allisve succis vel destillatis intingitur vel in pulverem redigitur vel in oleum convertitur."— *Wecker, Antidotorum Spec.* (1588) p. 17. And for modes of preparing the oil of gold and potable gold, see the same work, p. 251.

ipsum aurum; quod tamen sedulo celatur. Quod si aperiri possit aurum absque aquis corrosivis, aut per corrosivas (modo absit qualitas venenata) bene postea ablutas, rem non inutilem fore arbitramur.

2. Margaritæ sumuntur aut in pulvere lævigato, aut in malagmate quodam sive dissolutione per succum limonum impense acerborum et recentium; atque dantur aliquando in confectionibus aromaticis, aliquando in liquore. Margarita proculdubio affinitatem habet cum concha cui adhæret; et possit esse similis fere qualitatis cum testis cancrorum fluviatilium.

3. Inter gemmas crystallinas habentur pro cordialibus præcipue duæ; smaragdus et hyacinthus; quæ dantur sub iisdem formis quibus margaritæ, excepto quod dissolutiones earum (quod scimus) non sint in usu. Verum nobis magis suspectæ sunt gemmæ illæ vitreæ ob asperitatem.

Monitum. De his quæ memoravimus, quatenus et quomodo juvamentum præbeant, postea dicetur.

4. Lapis bezoar probatæ est virtutis[1]; quod spiritus recreet, et lenem sudorem provocet. Cornu autem monocerotis de existimatione sua decidit; ita tamen ut gradum servet cum cornu cervi, et osse de corde cervi, et ebore, et similibus.

5. Ambra Grisia ex optimis est ad spiritus demulcendos et confortandos. Sequuntur nomina tantum Simplicium, cum virtutes ipsarum satis sint cognitæ.

Calida. Crocus: folium Indum: lignum aloës: cortex citri: melissa: ocymum: gariophyllata: flores arantiorum: rosmarinus: menta: betonica: carduus benedictus.

Frigida. Nitrum: rosa: viola: fragaria: fraga: succus limonum dulcium: succus arantiorum dulcium: succus pomorum fragrantium: borago: buglossa: pimpinella: santalum: camphora.[2]

[1] Bezoar is a stone-like concretion found in the stomach of different animals, and particularly in that of a kind of goat in parts of Persia. It was supposed to be an antidote to almost all poisons, and its name is said to be a corruption of baal zoar, *i. e.* lord of poisons. Berthollet analysed three bezoars sent by the king of Persia to France, and found they consisted almost entirely of ligneous fibre. On incineration they left a residuum of salts of soda. Fourcroy and Vauquelin had previously asserted that the bezoar was a biliary concretion. The name has probably been applied to substances of essentially different natures.

[2] For an account of these simples I may refer to the work of Wecker already quoted.

Monitum. Cum de iis jam sermo sit quæ in diætam transferri possint, aquæ illæ ardentiores, atque olea chymica (quæ, ut ait quidam ex nugatoribus, sunt sub planeta Martis, et habent vim furiosam et destructivam), quinetiam aromata ipsa acria et mordacia, rejicienda sunt; et videndum quomodo componi possint aquæ et liquores ex præcedentibus; non phlegmaticæ illæ stillaticiæ, neque rursus ardentes ex spiritu vini, sed magis temperatæ, et nihilominus vivæ, et vaporem benignum spirantes.

6. Hæsitamus de frequenti sanguinis missione, utrum ad longævitatem conferat; et potius in ea sumus opinione, quod hoc faciat si in habitum versa fuerit, et cætera sint accommodata: etenim succum corporis veterem emittit, et novum inducit.

7. Arbitramur etiam morbos quosdam emaciantes, bene curatos, ad longævitatem prodesse; succos enim novos præbent veteribus consumptis; atque (ut ait ille) *convalescere est juvenescere;* itaque inducendi sunt tanquam morbi quidam artificiales, id quod fit per diætas strictas et emaciantes, de quibus postea dicemus.

INTENTIONES.

Ad Art. 12, 13, et 14. *Connexio.* Postquam autem inquisitionem absolverimus secundum subjecta, videlicet corporum inanimatorum, vegetabilium, animalium, hominis; propius accedemus, et inquisitionem per Intentiones ordinabimus: veras et proprias (ut omnino arbitramur), quæque sint tanquam semitæ vitæ mortalis. Neque enim in hac parte quicquam quod valeat hactenus inquisitum est; sed plane fuerunt hominum contemplationes quasi simplices et non proficientes. Nam cum audiamus ex una parte homines de confortando Calore Naturali atque Humore Radicali, atque de cibis qui generant sanguinem laudabilem, quique sit nec torridus nec phlegmaticus, atque de refocillatione et recreatione spirituum, verba facientes; existimamus sane homines non malos esse qui hæc loquuntur: sed nihil horum potenter facit ad finem. Cum vero ex altera parte audiamus sermones inferri de medicinis ex auro (quia scilicet aurum corruptioni est minime

obnoxium), et de gemmis ad recreandos spiritus, propter proprietates occultas et clarorem suum; quodque si possint detineri et excipi in vasibus balsama et quintæ essentiæ animalium, superbam faceret spem immortalitatis; quodque carnes serpentum et cervorum consensu quodam valeant ad renovationem vitæ, quia alter mutat spolia, alter cornua (debuerant autem carnes aquilarum adjungere, quia aquila mutat rostrum); quodque quidam, cum unguentum sub terra defossum reperisset, eoque se a capite ad pedes usque unxisset (exceptis plantis pedum [1]), ex hujusmodi unctione trecentos annos vixisset absque morbo (præter tumores plantarum pedum); atque de Artefio, qui cum spiritum suum labascere sensisset, spiritum adolescentis cujusdam robusti ad se traxisset, eumque inde exanimasset, sed ipse complures annos ex alieno illo spiritu vixisset [2]; et de horis fortunatis secundum schemata cœli, in quibus medicinæ ad vitam producendam colligi et componi debent; atque de sigillis planetarum, per quæ virtutes cœlitus ad prolongationem vitæ haurire et deducere possimus; et hujusmodi fabulosis et superstitiosis; prorsus miramur homines ita mente captos, ut iis hujusmodi res inponi possint. Denique subit humani generis miseratio,

[1] This story is taken from Roger Bacon. "Domina de Formerey in Britannia majori quærens cervam albam, unguentum comperit quo custos nemoris se perunxerat in toto corpore præterquam in plantis: vixit trecentis annis sine corruptione, exceptis pedum doloribus et passionibus."—*De mirab. Potest. Artis et Naturæ.* I quote from the edition printed in Paris in 1542. In Mangetus's *Bibli. Chym. Cur.* vol. i. and in the *Theatrum Chymicum*, v. 834., this tract of Bacon's is included. In the latter it is entitled "De secretis operibus artis et naturæ," and there may perhaps be other differences. Both in Mangetus's collection and in the *Theatrum* the lady is called "domina de nemore," and in the English version published in 1618 "the lady of the wood." But "de Formerey" is probably a better reading, and in the fourth volume of the *Theatrum Chymicum*, p. 791. Lagneus, in quoting the story from Roger Bacon has adopted it.

[2] I do not know where Bacon found this story of Artefius, who is quite a mythical personage. In the *Theatrum Chymicum* and in Mangetus, *Biblioth. Chym. Curios.* a tract entitled *Clavis Majoris Sapientiæ* is printed with his name. It was first published, according to Adelung, in Paris, in 1609, and seems to be the work of a modern cabalist. Roger Bacon makes frequent mention of him, and must have seen more of his supposed writings than this tract. Whatever his mode of prolonging life may have been, it seems to have been successful. "Artephius in sua sapientiâ secretorum vires et animalium et lapidum et cæterorum scrutans ob secreta naturæ scienda, et maxime propter vitæ longitudinem, gloriatur se vixisse mille et 25 annis."—*R. Bacon, De Mirabil. Potest.* In the *Opus Majus* he is said to have been a great traveller. "Artephius qui omnes regiones orientis peragravit propter sapientiam inquirendam [et] Tantalum magistrum regis Indiæ invenit in aureo throno sedentem (cui Artephio idem Tantalus humiliavit se in disciplinam) fertur in libro suo philosophiæ vixisse multis annorum centenariis per secretas experientias rerum."—*Majus Opus*, § *De Secret. Prær. Scient. Exper.* The statement that he lived a thousand and twenty-five years occurs a little farther on.

quod tam duro fato obsideatur inter res inutiles et ineptas. Nostras[1] autem Intentiones et rem ipsam premere et procul esse a commentis vanis et credulis confidimus; et tales, ut rebus quæ illis Intentionibus satisfaciant a posteris quamplurima, Intentionibus autem ipsis non multum addi, posse existimemus.

Sunt tamen pauca, sed magni prorsus momenti, quorum homines præmonitos esse volumus.

Primo, nos in hac sententia sumus, ut existimemus officia vitæ esse vita ipsa potiora. Itaque, si quid sit ejusmodi, quod Intentionibus nostris magis exacte respondere possit, ita tamen ut officia et munia vitæ omnino impediat; quicquid hujus generis sit rejicimus: levem fortasse aliquam mentionem hujusmodi rerum facimus, sed minime illis insistimus. Neque enim de vita aliqua in speluncis ubi radii et tempestates cœli non penetrent, instar antri Epimenidis; aut de perpetuis balneis ex liquoribus præparatis; aut de superpelliciis et ceratis ita applicandis, ut corpus perpetuo sit tanquam in capsula; aut de pigmentis spissis, more barbarorum nonnullorum; aut de ordinatione victus et diætæ accurata, quæ solum hoc videatur agere, et nihil aliud curare, quam ut quis vivat (qualis fuit Herodici[2] apud antiquos, et Cornari[3] Veneti nostro sæculo, sed majore cum moderatione); aut de hujusmodi portentis, fastidiis, et incommodis, sermonem aliquem serium et diligentem instituimus; sed ea afferimus remedia et præcepta, ex quibus officia vitæ non deserantur, aut nimias excipiant moras et molestias.

Secundo, ex altera parte, hominibus denuntiamus, ut nugari desinant, nec existiment tantum opus, quantum est naturæ potentem cursum remorari et retrovertere, posse haustu aliquo matutino, aut usu alicujus pretiosæ medicinæ,

[1] *Nostras* in the original.—*J. S.*

[2] Plato, Republic. iii.

[3] The first edition of Cornaro's tracts on the prolongation of life was published in 1558. But it only contains three of the four tracts included in the complete editions. Lessius appended a Latin translation of Cornaro to his *Hygiasticon*, published in 1613. Of this and of Cornaro's own work, an English translation (that of Cornaro by George Herbert) was published in 1636. The editor prefixes an extract from the *Hist. Vitæ et Mort.* in commendation of Cornaro, saying that he thinks it not amiss "to make use of the decree of that Great Chancellor of Learning as well as of the Law, the late viscount St. Alban's." The book concludes with a translation of an Italian discourse in favour of temperance, the name of the author of which is not mentioned. Several copies of introductory verses are prefixed to the editor's preface, one by Crashaw of singular beauty.

ad exitum perduci; sed ut pro certo habeant, necesse esse ut hujusmodi opus sit plane res operosa, et quæ ex compluribus remediis, atque eorum inter se connexione idonea, constet; neque enim quisquam ita stupidus esse debet, ut credat id quod nunquam est factum fieri posse, nisi per modos etiam nunquam tentatos.

Tertio diserte profitemur, nonnulla ex iis quæ proponemus experimento nobis non esse probata (neque enim hoc patitur nostrum genus vitæ), sed tantum summa (ut arbitramur) ratione, ex principiis nostris et præsuppositis (quorum alia inserimus, alia mente servamus) esse derivata, et tanquam ex rupe aut minera ipsius naturæ excisa et effossa. Neque tamen curam omisimus, eamque providentem et sedulam, quin (quandoquidem de corpore humano agatur, quod, ut ait Scriptura, *est supra vestimentum*) ea proponamus remedia, quæ sint tuta saltem, si forte non fuerint fructuosa.

Quarto, illud homines rite et animadvertere et distinguere volumus; non eadem semper, quæ ad vitam sanam, ad vitam longam conferre. Sunt enim nonnulla quæ ad spirituum alacritatem et functionum robur et vigorem prosunt, quæ tamen de summa vitæ detrahunt. Sunt et alia quæ ad prolongationem vitæ plurimum juvant, sed tamen non sunt absque periculo valetudinis; nisi per accommodata quædam huic rei occurratur; de quibus tamen (prout res postulat) cautiones et monita exhibere non prætermittemus.

Postremo, visum est nobis varia remedia, secundum singulas Intentiones, proponere; delectum vero remediorum, atque ordinem ipsorum, in medio relinquere. Etenim ex ipsis, quæ constitutionibus corporum diversis, quæ generibus vitæ variis, quæ ætatibus singulis, maxime conveniant, quæque alia post alia sumenda sint, et quomodo praxis universa harum rerum sit instruenda et regenda, exacte perscribere, et nimis longum foret, neque idoneum est quod publicetur.

Intentiones in Topicis proposuimus tres. Prohibitionem Consumptionis; Perfectionem Reparationis; et Renovationem Veterationis. Verum, cum quæ dicentur nihil minus sint quam verba, Intentiones illas tres ad decem Operationes deducemus.

1. Prima est operatio super spiritus, ut revirescant.

2. Secunda operatio est super exclusionem aëris.

3. Tertia operatio est super sanguinem et calorem sanguificantem.

4. Quarta operatio est super succos corporis.

5. Quinta operatio est super viscera, ad extrusionem alimenti.

6. Sexta operatio est super partes exteriores, ad attractionem alimenti.

7. Septima operatio est super alimentum ipsum, ad insinuationem ejusdem.

8. Octava operatio est super actum ultimum assimilationis.

9. Nona operatio est super intenerationem partium, postquam cœperint desiccari.

10. Decima operatio est super expurgationem succi veteris, et substitutionem succi novi.

Harum operationum primæ quatuor pertinent ad intentionem primam ; quatuor proximæ ad intentionem secundam ; duæ ultimæ ad intentionem tertiam.

Cum vero hæc pars de intentionibus ad praxin innuat ; sub historiæ nomine, non solum experimenta et observationes, sed etiam consilia, remedia, causarum explicationes, assumpta, et quæcunque huc spectant, immiscebimus.

I.

OPERATIO SUPER SPIRITUS, UT MANEANT JUVENILES, ET REVIVESCANT.

Historia.

1. Spiritus omnium quæ in corpore fiunt fabri sunt atque opifices. Id et consensu et ex infinitis instantiis patet.

2. Si quis posset efficere, ut in corpore senili rursus indantur spiritus quales sunt in juvene, rotam hanc magnam rotas reliquas minores circumagere et naturæ cursum retrogradum fieri posse consentaneum est.

3. In omni consumptione, sive per ignem sive per ætatem, quo plus spiritus rei sive calor deprædatur humorem, eo brevior est duratio rei. Id ubique occurrit et patet.

4. Spiritus in tali temperamento et gradu activitatis ponendi sunt, ut succos corporis (ut ait ille) *non bibant et sorbeant, sed pitissent.*

5. Duo sunt genera flammarum; una acris et impotens, quæ tenuiora evolare facit, in duriora parum potest; ut flamma ex stramine vel ramentis ligni: altera fortis et constans, quæ etiam insurgit in dura et obstinata; qualis est lignorum grandiorum et similium.

6. Flammæ acriores, et tamen minus robustæ, corpora desiccant, et reddunt effœta et exucta; at fortiores corpora intenerant et liquant.

7. Etiam ex medicinis dissipantibus, nonnullæ in tumoribus tenuia tantum emittunt, ideoque indurant: nonnullæ potenter discutiunt, ideoque emolliunt.

8. Etiam in purgantibus et abstergentibus, quædam magis fluida raptim asportant; quædam magis contumacia et viscosa trahunt.

9. Spiritus tali calore indui et armari debent, ut potius ament dura et obstinata convellere et subruere, quam tenuia et præparata emittere et asportare: eo enim modo fit corpus viride et solidum.

10. Spiritus ita subigendi et componendi sunt, ut fiant substantia densi, non rari; calore pertinaces, non acres; copia quanta sufficit ad munia vitæ, non redundantes aut turgidi; motu sedati, non subsultorii et inæquales.

11. Super spiritus plurimum operari et posse vapores, ex somno, et ebrietate, et passionibus melancholicis et lætificantibus, et recreatione spirituum per odores in deliquiis et languoribus, patet.

12. Spiritus quatuor modis condensantur; aut fugando; aut refrigerando; aut demulcendo; aut sedando. Atque primum de condensatione per fugam videndum.

13. Quicquid fugat undequaque, cogit corpus in centrum suum, atque ideo condensat.

14. Ad condensationem spirituum per fugam longe potentissimum et efficacissimum est opium; et deinde opiata, atque generaliter soporifera.

15. Efficacia opii ad condensationem spirituum admodum insignis est; cum tria fortasse grana ejus spiritus paulo post

ita coagulent, ut non redeant, sed extinguantur, et reddantur immobiles.

16. Opium et similia non fugant spiritus propter frigus suum (habent enim partes manifesto calidas), sed e converso refrigerant propter fugam spirituum.

17. Fuga spirituum ex opio et opiatis optime cernitur in illis exterius applicatis; quia subinde spiritus statim se subducunt, nec amplius accedere volunt, sed mortificatur pars, et vergit ad gangrænam.

18. Opiata in magnis doloribus, veluti calculi, aut in abscissione membrorum, dolores mitigant; maxime per fugam spirituum.

19. Opiata sortiuntur bonum effectum ex mala causa; fuga enim spirituum mala; condensatio autem eorum a fuga, bona.

20. Græci multum posuerunt, et ad sanitatem, et ad prolongationem vitæ, in opiatis: Arabes vero adhuc magis; in tantum ut medicinæ suæ grandiores (quas *Deorum Manus* vocant [1]) pro basi sua et ingrediente principali habeant opium; reliquis admistis ad ejus noxias qualitates retundendas et corrigendas; quales sunt Theriaca, Mithridatium, et cætera.[2]

21. Quicquid in cura morborum pestilentialium et malignorum fœliciter exhibetur, ut spiritus sistantur et frænentur ne turbent et tumultuentur, id optime transfertur ad prolongationem vitæ; cum idem faciat ad utrumque; condensatio videlicet spirituum. Id autem præstant ante omnia opiata.

22. Turcæ opium experiuntur, etiam in bona quantitate, innoxium et confortativum; adeo ut etiam ante prælia ad fortitudinem illud sumant [3]; nobis vero, nisi in parva quantitate, et cum bonis correctivis, lethale est.

23. Opium et opiata manifesto deprehenduntur excitare venerem; quod testatur vim ipsarum ad roborandos spiritus.

24. Aqua stillatitia ex sylvestri papavere ad crapulam, febres, et varios morbos fœliciter adhibetur; quæ proculdubio est temperatum genus opiati: neque de varietate usus ejus miretur quispiam; id enim opiatis familiare est; quia spiritus roboratus et densatus insurgit in quemcunque morbum.

25. Turcæ habent etiam in usu herbæ genus [4], quam vocant

[1] Τὰς βασιλικὰς καὶ ἀλεξιφαρμάκους ἐκείνας δυνάμεις ἃς θεῶν χεῖρας ὠνόμαζεν Ἐρασίστρατος.—*Plutarch, Symposiac*, iv. 1.

[2] See Wecker, *Antid. Spec.* tit. De Opiatis.

[3] Sandys's Travels, p. 52. of ed. 1670.

[4] In the *Sylva* Bacon speaks more correctly. He there calls coffee a berry.

Caphe, quam desiccatam pulverizant, et in aqua calida propinant; quam dicunt haud parvum præstare illis vigorem, et in animis et in ingeniis: quæ tamen, largius sumpta, mentem movet et turbat; unde manifestum est eam esse similis naturæ cum opiatis.

26. Celebratur in universo oriente radix quædam vocata *Betel*, quam Indi et reliqui in ore habere et mandere consueverunt; atque ex ea mansione mire recreantur, et ad labores tolerandos, et ad languores discutiendos, et ad coïtum fortificandum; videtur autem esse ex narcoticis, quia magnopere denigrat dentes.

27. Incœpit nostro sæculo in immensum crescere usus *Tobacco;* atque afficit homines occulta quadam delectatione, ut qui illi semel assueti sint, difficile postea abstineant; et facit proculdubio ad corpus allevandum, et tollendas lassitudines; atque vulgo virtus ejus refertur eo, quod aperiat meatus et eliciat humores: attamen rectius referri potest ad condensationem spirituum, cum sit Hyoscyami quoddam genus, et caput manifesto turbet, quemadmodum opiata.

28. Sunt aliquando humores generati in corpore, qui et ipsi sunt tanquam opiati; ut fit in aliquibus melancholiis, quibus si quis corripiatur, admodum fit longævus.

29. Opiata (quæ etiam narcotica vocantur et stupefactiva) simplicia, sunt opium ipsum, quod est succus papaveris; papaver utrunque, et in herba et in semine; hyoscyamus; mandragora; cicuta; tobacco; solanum.

30. Opiata composita, sunt theriaca, mithridatium, triferæ, ladanum Paracelsi, diacodium, diascordium, philonium, pilulæ de cynoglossa.[1]

31. Ex his quæ dicta sunt, possent deduci quædam *Designationes*, sive consilia, ad prolongationem vitæ, secundum hanc Intentionem, scilicet Condensationis Spirituum per Opiata.

32. Sit itaque quotannis, a juventute adulta, diæta quædam opiata. Usurpetur sub fine Maii; quia spiritus æstate maxime solvuntur et attenuantur, et minor instat metus ab humoribus frigidis: sit vero opiatum aliquod magistrale, debilius quam ea quæ in usu sunt, et quoad minorem quantitatem opii, et quoad parciorem mixturam impense calidorum: sumatur mane inter somnos: victus sit simplicior et parcior, absque vino, aut aromatibus, aut vaporosis: sumatur autem medicina alternis tan-

[1] Most of these are mentioned by Wecker.

tum diebus, et continuetur diæta ad quatuordecim dies. Hæc Designatio judicio nostro Intentioni haud perperam satisfacit.

33. Possit etiam esse acceptio opiatorum, non tantum per os, sed etiam per fumos: sed talis esse debet, ut non moveat nimis facultatem expulsivam, aut eliciat humores; sed tantum brevi mora operetur super spiritus intra cerebrum; itaque suffumigatio matutina, per os et nares excepta, cum tobacco, admisto ligno aloës et foliis siccis roris marini et parum myrrhæ, utilis foret.

34. In opiatis magnis, qualia sunt theriaca, mithridatium, et cætera, (præsertim in juventute) non malum foret potius aquas ipsorum stillatitias sumere, quam corpora ipsorum; etenim vapor in distillando surgit, calor medicamenti fere subsidet: aquæ autem stillatitiæ plerunque in virtutibus quæ per vapores fiunt, bonæ; in cæteris, enerves.

35. Sunt medicamenta, quæ gradum habent quendam debilem et occultum, et propterea tutum, ad virtutem opiatam. Ea immittunt vaporem lentum et copiosum, sed non malignum, quemadmodum opiata faciunt. Itaque spiritus non fugant, sed congregant tamen, et nonnihil inspissant.

36. Medicamenta in ordine ad opiata sunt ante omnia crocus, atque ejus flores; deinde folium Indum; ambra-grisia; coriandri semen præparatum; amomum et pseudamomum; lignum Rhodium; aqua florum arantiorum, et multo magis infusio florum eorundem recentium in oleo amygdalino; nux muscata foraminata et in aqua rosacea macerata.

37. Ut opiata parce admodum et certis temporibus (ut dictum est), ita hæc secundaria familiariter, et in victu quotidiano, sumi possunt; et multum conferent ad prolongationem vitæ. Certe pharmacopœus quidam Calecutiæ, ex usu ambræ, ad centum sexaginta annos vixisse perhibetur; atque nobiles in Barbaria, ex ejusdem usu, longævi reperiuntur, cum plebs brevioris sit ævi; et apud majores nostros, qui nobis fuerunt vivaciores, crocus magno in usu fuit, in placentis, jusculis, &c. Atque de primo modo condensationis spirituum, per opiata et subordinata, hæc inquisita sint.

38. Jam vero de secundo modo condensationis spirituum, per frigus, inquiremus; proprium enim opus frigoris est densatio; atque perficitur absque malignitate aliqua, aut qualitate inimica: ideoque tutior est operatio, quam per opiata; licet paulo minus potens, si per vices tantum, quemadmodum opiata, usurparetur.

At rursus, quia familiariter et in victu quotidiano moderate adhiberi potest, etiam longe potentior ad prolongationem vitæ est quam per opiata.

39. Refrigeratio spirituum fit tribus modis; aut per respirationem; aut per vapores; aut per alimenta. Prima optima est, sed fere extra nostram potestatem; secunda etiam potens, et tamen præsto est; tertia debilis et per circuitus.

40. Aër limpidus et purus, et nihil habens fuliginis, antequam recipiatur in pulmones, et minus obnoxius radiis solis, spiritus optime densat. Talis invenitur aut in jugis montium siccis, aut in campestribus perflatilibus et tamen umbrosis.

41. Quoad refrigerationem et densationem spirituum per vapores, radicem hujus operationis ponimus in nitro, veluti creatura ad hoc propria et electa; his usi et persuasi indiciis.

42. Nitrum est tanquam aroma frigidum; idque indicat sensus ipse. Mordet enim et tentat linguam et palatum frigore, ut aromata calore; atque inter ea quæ novimus, unicum est et solum quod hoc præstet.

43. Frigida fere omnia (quæ sunt proprie frigida, non per accidens, ut opium) habent spiritum exilem et paucum; contra spirituosa sunt omnia fere calida. Solum invenitur nitrum in natura vegetabili, quod spiritu abundet et tamen sit frigidum. Nam caphura, quæ est spirituosa et tamen edit actiones frigidi, refrigerat per accidens tantum; nempe tenuitate sua, absque acrimonia, juvando perspirationem in inflammationibus.

44. In congelatione et conglaciatione liquorum, quæ nuper cœpit esse in usu, per nivem et glaciem ad exteriora vasis appositas, immiscetur nitrum [1]; atque proculdubio excitat et roborat congelationem: verum est, etiam usurpari ad hoc salem nigrum communem, qui potius activitatem indit frigori nivali, quam per se infrigidat; sed, ut accepi, in regionibus calidioribus, ubi nix non cadit, fit conglaciatio a nitro solo: sed hoc mihi compertum non est.

45. Pulvis pyrius, qui præcipue constat ex nitro, perhibetur epotus conducere ad fortitudinem, et usurpari a nautis sæpenumero et militibus ante prælia, quemadmodum a Turcis opium.

46. Datur fœliciter nitrum in causonibus et febribus pestilentialibus, ad leniendos et frænandos ardores earum perniciosos.

47. Manifestissimum est nitrum in pulvere pyrio magnopere

[1] For some account of the early use of frigorific mixtures, see Beckmann, *Hist. of Invent.* iii. 346. (English translation, 1817).

exhorrere flammam; unde fit admirabilis illa ventositas ex exufflatio.

48. Nitrum deprehenditur esse veluti spiritus terræ: etenim certissimum est, quamcunque terram, licet puram neque nitrosis admixtam, ita accumulatam et tectam ut immunis sit a radiis solis, neque emittat aliquod vegetabile, colligere etiam satis copiose nitrum; unde liquet spiritum nitri, non tantum spiritui animalium, verum etiam spiritui vegetabilium esse inferiorem.

49. Animalia quæ potant ex aqua nitrosa manifesto pinguescunt; quod signum est frigidi in nitro.

50. Impinguatio soli maxime fit a nitrosis; omnis enim stercoratio est nitrosa: atque hoc signum est spiritus in nitro.

51. Ex his patet spiritus humanos per spiritum nitri posse infrigidari et densari, et fieri magis crudos et minus acres: quemadmodum igitur vina fortia et aromata et similia spiritus incendunt, et vitam abbreviant; ita et nitrum e converso illos componit et comprimit, et facit ad longævitatem.

52. Usus autem nitri potest esse in cibo inter salem, ad decimam partem salis; in jusculis matutinis, ad grana a tribus ad decem; etiam in potu; sed qualitercunque usurpatum cum modo, ad longævitatem summe prodest.

53. Quemadmodum opium præcipuas partes tenet in condensatione spirituum per fugam, atque habet simul sua subordinata, minus potentia, sed magis tuta, quæ et majori quantitate et frequentiori usu sumi possunt, de quibus superius diximus: ita similiter et nitrum, quod condensat spiritus per frigus et quandam (ut moderni loquuntur) *frescuram*, habet quoque et ipsum sua subordinata.

54. Subordinata ad nitrum sunt omnia quæ exhibent odorem nonnihil terreum; qualis est odor terræ puræ et bonæ, recenter effossæ et versatæ. In his præcipua sunt borago, buglossa, hippo-buglossa, pimpinella, fragaria, et fraga ipsa, frambesia, fructus cucumeris crudus, poma cruda fragrantia, folia et gemmæ vitis, etiam viola.

55. Proxima sunt ea quæ habent quendam virorem odoris, sed paulo magis vergentem ad calidum, neque omnino expertem virtutis illius refrigerii: qualia sunt melissa, citrum viride, arantium viride, aqua rosacea stillatitia, pyra assa fragrantia, etiam rosa pallida, rubea, et muscatella.

56. Illud notandum est, subordinata ad nitrum plerunque plus ad intentionem conferre cruda, quam ignem passa; quia

spiritus ille refrigerii ab igne dissipatur; itaque bene sumuntur infusa in potu, aut cruda.

57. Quemadmodum condensatio spiritus per subordinata ad opium fit aliquatenus per odores; similiter et illa, quæ fit per subordinata ad nitrum; itaque odor terræ recentis et puræ spiritus optime compescit, sive aratrum sequendo, sive fodiendo, sive herbas inutiles evellendo; etiam folia, in sylvis et sepibus vergente autumno decidentia, bonum refrigerium præstant spiritibus; et maxime omnium, fragaria moriens. Etiam odor violæ, aut florum parietariæ, aut fabarum, aut rubi suavis, et madreselve [1], exceptus dum crescunt, similis est naturæ.

58. Quin et novimus virum nobilem longævum, qui statim a somno glebam terræ recentis sub nares apponi quotidie fecit, ut ejus odorem exciperet.

59. Dubium non est, quin refrigeratio et attemperatio sanguinis per frigida, qualia sunt endivia, cichorea, hepatica, portulaca, &c. per consequens infrigidet quoque spiritus; sed hoc fit per circuitum; at vapores operantur immediate.

Atque de condensatione spirituum per frigus jam inquisitum est. Tertiam diximus esse condensationem per id quod vocamus *demulcere spiritus;* quartam, per sedationem alacritatis et motus nimii ipsorum.

60. Demulcent spiritus quæcunque illis sunt grata atque amica; neque tamen provocant eos nimium ad exterius; sed contra faciunt ut spiritus, quasi seipsis contenti, se fruantur, et recipiant se in centrum suum.

61. De his, si repetas ea quæ superius posita sunt tanquam subordinata et ad opium et ad nitrum, nihil est opus alia inquisitione.

62. Quod vero ad sedationem impetus spirituum attinet, de ea mox dicemus, cum de motu ipsorum inquiremus: nunc igitur postquam de densatione spirituum dixerimus (quæ pertinet ad substantiam ipsorum), veniendum ad modum caloris in ipsis.

63. Calor spirituum, ut diximus, ejus generis esse debet, ut sit robustus, non acris; et amet obstinata subruere, potius quam attenuata asportare.

64. Cavendum ab aromatibus, vino, et potu forti; ut usus ipsorum sit valde temperatus et abstinentia interpolatus: etiam a satureia, origano, pulegio, et omnibus quæ ad palatum acris

[1] Clary, a kind of Salvia.

sunt et incensiva. Illa enim præstant spiritibus calorem non fabrilem, sed prædatorium.

65. Robustum præbent calorem præcipue enula[1], allium, carduus benedictus, nasturtium adolescens, chamædrys, angelica, zedoaria, verbena, valeriana, myrrha, costum, sambuci flores, myrrhis. Horum usus cum delectu et judicio, alias in condimentis, alias in medicamentis, huic operationi satisfaciet.

66. Bene etiam cedit, quod opiata magna huic quoque operationi egregie serviunt; eo videlicet, quod exhibent calorem talem per compositionem, qualis in simplicibus optatur, sed vix habetur: etenim recipiendo calida illa intensissima (qualia sunt euphorbium, pyrethrum, stachys-agra, dracontium, anacardi[2], castoreum, aristolochium, opopanax, ammoniacum, galbanum, et similia; quæ intus per se sumi non possunt) ad retundendam vim narcoticam opii, constituunt demum talem complexionem medicamenti, qualem jam requirimus; quod optime perspicitur in hoc, quod theriaca et mithridatium, et reliqua, non sunt acria nec mordent linguam; sed tantum sunt paululum amara, et odoris potentis, et produnt demum caliditatem suam in stomacho et operationibus sequentibus.

67. Etiam ad calorem robustum spirituum facit venus sæpe excitata, raro peracta; atque nonnulli ex affectibus, de quibus postea dicetur. Atque de calore spirituum, analogo ad prolongationem vitæ, jam inquisitum est.

68. De copia spirituum, ut non sint exuberantes et ebullientes, sed potius parci et intra modum, (cum flamma parva non tantum prædetur, quantum magna) brevis inquisitio est.

69. Videtur ab experientia comprobari, quod diæta tenuis et fere Pythagorica, vel ex regulis severioribus vitæ Monasticæ, vel ex institutis eremitarum, quæ necessitatem et inopiam habebant pro regula, vitam reddat longævam.

70. Huc pertinent potus aquæ, stratum durum, aër frigidus, victus tenuis (scilicet ex oleribus, fructibus, atque carnibus et piscibus conditis et salitis, potius quam recentibus et calidis), indusium cilicii, crebra jejunia, crebræ vigiliæ, raræ voluptates sensuales, et hujusmodi: omnia enim ista minuunt spiritus, eosque redigunt ad quantitatem eam, quæ tantummodo vitæ muniis sufficiat; unde minor fit deprædatio.

71. Quod si diæta fuerit hujusmodi rigoribus et mortificationibus paulo benignior, sed tamen semper æqualis, et sibi

[1] Elecampane. [2] Anacardium is the Malacca bean.

constans, eandem opem præstat; etenim etiam in flammis videmus, flammam nonnihil majorem (modo fuerit constans et tranquilla) minus absumere ex fomite suo, quam flamma minor agitata, et per vices intensior et remissior: id quod plane demonstravit regimen et diæta Cornari Veneti, qui bibit et edit tot annos ad justum pondus; unde centesimum annum viribus et sensibus validus superavit.

72. Etiam videndum est, ne corpus quod plenius nutritur, neque per hujusmodi (quales diximus) diætas emaciatur, veneris usum tempestivum omittat; ne spiritus nimis turgeant, et corpus emolliant et destruant. Itaque de copia spiritus moderata, et quasi frugali, jam inquisitum est.

73. Sequitur inquisitio de frænatione motus spiritus; motus enim manifesto eum attenuat et incendit. Illa frænatio fit tribus modis: per somnum; per evitationem laboris vehementis aut exercitii nimii, denique omnis lassitudinis; et per cohibitionem affectuum molestorum. Ac primo de somno.

74. Fabula habet Epimenidem in antro plures annos dormivisse, neque alimento eguisse, cum spiritus inter dormiendum minus depascat.

75. Experientia docet animalia quædam (qualia sunt sorices et vespertiliones) in quibusdam locis occlusis per integram hiemem dormire; adeo somnus deprædationem vitalem compescit; quod etiam facere putantur apes et fuci, licet quandoque a melle destituti: itidem papiliones et muscæ.

76. Somnus post prandium, ascendentibus in caput vaporibus non ingratis (utpote primis roribus ciborum), spiritibus prodest, sed ad alia omnia, quæ ad sanitatem pertinent, gravis est et noxius; attamen in extrema senectute eadem est ratio cibi et somni; quia frequens esse debet et refectio et dormitio, sed brevis et pusilla: quinetiam ad ultimam metam senectutis mera quies et perpetuus quasi decubitus prodest, præsertim temporibus hiemalibus.

77. Verum ut somnus moderatus ad prolongationem vitæ facit, ita multo magis, si sit placidus et non turbidus.

78. Somnum placidum conciliant, viola, lactuca (præsertim cocta), syrupus e rosis siccis, crocus, melissa, poma in introitu lecti, offa panis ex vino malvatico [1], præsertim infusa prius rosa muscatella: itaque utile foret conficere aliquam pilulam vel aliquem haustum parvum ex hujusmodi rebus, eoque uti fami-

[1] Malmsey.

liariter. Etiam ea quæ os ventriculi bene claudunt, ut semen coriandri præparatum, cotonea, et pyra fragrantia assata, somnum inducunt placidum; ante omnia, juvenili ætate, et maxime iis qui habent ventriculum satis fortem, prodest haustus bonus aquæ puræ, crudæ, in introitu lecti.

Mendatum. De ectasi voluntaria, sive procurata, atque de cogitationibus defixis et profundis (modo sint absque molestia) nihil habeo comperti; faciunt proculdubio ad Intentionem, et densant spiritus, etiam potentius quam somnus; cum sensus æque aut magis sopiant et suspendant. De illis inquiratur ulterius. Atque de somno hactenus.

79. Quatenus ad motum et exercitia; lassitudo nocet, atque motus et exercitatio quæ est nimis celeris et velox, quales sunt cursus, pila, gladiatoria, et similia; et rursus cum impetus extenditur ad ultimas vires et nixus, quales sunt saltus, lucta, et similia. Certum enim est, spiritus in angustiis positos, vel per pernicitatem motus vel per ultimos nixus, fieri postea magis acres et prædatorios. Ex altera parte, exercitia quæ satis fortem cient motum, sed non nimis celerem aut ad ultimas vires, (quales sunt saltatio, sagittatio, equitatio, lusus globorum, et similia) nihil officiunt, sed prosunt potius.

Veniendum jam ad affectus et passiones animi, et videndum qui ex ipsis ad longævitatem sint noxii, qui utiles.

80. Gaudia magna attenuant et diffundunt spiritus, et vitam abbreviant: lætitia familiaris roborat spiritus, evocando eos, nec tamen exsolvendo.

81. Impressiones gaudiorum sensuales, malæ; ruminationes gaudiorum in memoria, aut prehensiones eorum ex spe vel phantasia, bonæ.

82. Magis confortat spiritus gaudium pressum et parce communicatum, quam gaudium effusum et publicatum.

83. Mœror et tristitia, si metu vacet et non nimium angat, vitam potius prolongat: spiritus enim contrahit, et est condensationis genus.

84. Metus graviores vitam abbreviant: licet enim et mœror et metus spiritum uterque angustiet, tamen in mœrore est simplex contractio, at in metu, propter curas de remedio et spes intermistas, fit æstus et vexatio spirituum.

85. Ira compressa est etiam vexationis genus; et spiritum corporis succos carpere facit; at sibi permissa et foras prodiens

juvat; tanquam medicamenta illa, quæ robustum inducunt calorem.

86. Invidia pessima est, et carpit spiritus, atque illi rursus corpus; eo magis, quod fere perpetua est, nec *agit* (ut dicitur) *festos dies.*

87. Misericordia ex malo alieno, quod in nos ipsos cadere non posse videtur, bona; quæ vero similitudine quadam potest reflecti in miserantem, mala, quia excitat metum.

88. Pudor levis minime officit, cum spiritus paululum contrahat et subinde effundat; adeo ut verecundi diu (ut plurimum) vivant: at pudor ex ignominia magna et diu affligens, spiritus contrahit, usque ad suffocationem, et est perniciosus.

89. Amor, si non fuerit infœlix et nimis saucians, ex genere gaudii est; et easdem subit leges quas de gaudio posuimus.

90. Spes omnium affectuum utilissima est, et ad prolongationem vitæ plurimum facit; si non nimium sæpe intercidat, sed phantasiam boni intuitu pascat: itaque qui finem aliquem, tanquam metam vitæ, figunt et proponunt, et perpetuo et sensim in voto suo proficiunt, vivaces ut plurimum sunt; adeo ut, cum ad culmen spei suæ venerint, nec habeant quod amplius sperent, fere animis concidant, nec diu superstites sint; ut spes videatur tanquam *gaudium foliatum*, quod in immensum extenditur, sicut aurum.

91. Admiratio, et levis contemplatio, ad vitam prolongandam maxime faciunt; detinent enim spiritus in rebus quæ placent, nec eos turbare aut inquiete et morose agere sinunt; unde omnes contemplatores rerum naturalium, qui tot et tanta habebant quæ mirarentur (ut Democritus, Plato, Parmenides, Apollonius), longævi fuerunt: etiam rhetores, qui res degustabant tantum et potius orationis lumen quam rerum obscuritatem sectabantur, fuerunt itidem longævi; ut Gorgias, Protagoras, Isocrates, Seneca: atque certe quemadmodum senes plerunque garruli et loquaces sunt, ita et loquaces sæpissime senescunt: indicat enim levem contemplationem, et quæ spiritum non magnopere stringat aut vexet: at inquisitio subtilis et acuta et acris vitam abbreviat; spiritum enim lassat et carpit.

Atque de motu spirituum per animi affectus hæc inquisita sint; subjungemus autem quasdam alias observationes generales circa spiritus, præter superiores, quæ non cadunt in distributionem præcedentem.

92. Præcipuæ curæ esse debet, ut spiritus non exolvantur sæpius; solutionem enim præcedit extenuatio, neque spiritus semel extenuatus ita facile se recipit et densatur: exolutio autem fit per nimios labores; nimis vehementes affectus animi; nimios sudores; nimias evacuationes; balnea tepida; et intemperatum aut intempestivum usum veneris; etiam nimias curas et solicitudines, et expectationes anxias; denique per morbos malignos; et dolores et cruciatus corporis graves: quæ omnia quantum fieri potest (ut etiam medici vulgares monent) evitanda sunt.

93. Spiritus et consuetis delectantur et novis. Mirum autem in modum facit ad conservandum vigorem spirituum, ut nec consuetis utamur ad satietatem, nec novis ante appetitum vividum et strenuum. Itaque et consuetudines abrumpendæ sunt judicio quodam et cura, antequam perveniant ad fastidium; et appetitus ad nova ad tempus cohibendus, donec fiat fortior et alacrior. Atque insuper vita, quoad fieri potest, ita instituenda, ut multas et varias habeat redintegrationes, neque perpetuo in iisdem versando spiritus torpeant: licet enim non male dictum sit a Seneca, *Stultus semper incipit vivere*,[1] tamen illa stultitia, ut et aliæ quamplurimæ, longævitati prodest.

94. Circa spiritus observandum est (etsi contrarium fieri consueverit), ut quando percipiant homines spiritus suos esse in statu bono et placido et sano (id quod ex tranquillitate animi et lætitia datur perspici), eos foveant, nec mutent; sin in statu inquieto et maligno (id quod ex tristitia, pigritia, atque alia indispositione animi apparebit), eos subinde obruant et alterent. Continentur autem spiritus in eodem statu per cohibitionem affectuum, temperamentum diætæ, abstinentiam a venere, moderationem a labore, otium mediocre: alterant autem et obruunt spiritus contraria istis; scilicet, affectus vehementes, epulæ profusæ, venus immoderata, labores ardui, studia intensa, et negotia. Atqui consueverunt homines, cum læti sunt et sibi maxime placent, tum epulas, venerem, labores, contentiones, negotia, maxime sequi et affectare. Quod si quis longitudini vitæ consulere velit, contrario modo (quod mirum dictu) se gerere debet; spiritus enim bonos fovere et continuare, male dispositos exhaurire et mutare, oportet.

[1] "Inter cætera mala hoc quoque habet stultitia, semper incipit vivere."—*Sen. Ep.* 13.

95. Non inepte ait Ficinus, senes debere ad confortationem spirituum suorum, acta pueritiæ suæ et adolescentiæ sæpe recordari et ruminare.[1] Certa recreatio est senibus singulis, tanquam peculiaris, recordatio talis. Itaque dulce est hominibus societatem habere eorum, qui olim una educati fuerant, et loca ipsa educationis suæ invisere. Vespasianus autem huic rei tantum tribuebat, ut cum esset imperator nullo modo animum inducere potuisset, ut ædes paternas, licet humiles, mutaret; ne aliquid deperiret consuetudini oculorum et memoriæ pueritiæ suæ; quinetiam in scypho quodam aviæ suæ ligneo, cum labro argenteo, diebus festis potabat.[2]

96. Illud ante omnia spiritibus gratum est; ut fiat progressus continue in benignius. Itaque eo modo est instituenda juventus et ætas virilis, ut senectuti nova solatia relinquantur; quorum præcipuum sit otium moderatum. Itaque sibi ipsi manus inferunt senes honorati, qui in otium non secedunt: cujus rei insigne reperitur exemplum in Cassiodoro, qui tanta apud reges Italiæ Gothos auctoritate pollebat, ut instar animæ esset erga eorum negotia; postea autem fere octogenarius in monasterium se recepit, ubi non ante centesimum demum annum vitam clausit.[3] At huic rei duæ cautiones adhibendæ sunt; una, ut non expectent donec corpus omnino confectum sit et morbidum; etenim in hujusmodi corporibus omnis mutatio, licet in benignius, mortem accelerat; altera, ut otio plane inerti se minime dedant, sed habeant aliquid quod cogitationes et animum ipsorum placide detinere possit; in quo genere, præcipua oblectamenta sunt literæ, deinde studia ædificandi et plantandi.

97. Postremo, eadem actio, contentio, labor, libenter susceptus et cum bona voluntate, spiritus recreat; cum aversatione autem et ingratiis, spiritus carpit et sternit: itaque ad longævitatem confert, si quis arte talem vitam instituat quæ libera sit et ad arbitrium suum traducatur; aut tale obsequium animo suo conciliaverit, ut quicquid a fortuna imponatur eum potius ducat quam trahat.

[1] "Ludos quosdam et mores, quoad decet, olim anteactæ pueritiæ revocent."—*Ficinus, De Vit. Prod.* 8. But the context shows that Ficinus recommends the resumption of the amusements and habits of boyhood, and not merely the habitual recollection of them.

[2] Sueton. in Vesp. 2.

[3] Cassiodorus renounced the world in the reign of Vitiges, that is about 537, and died after 562. He must have lived nearly a hundred years, certainly more than ninety-three. See the preface to his *Orthography* in Baronius, an. 562.

98. Neque illud omittendum ad regimen affectuum; ut præcipua cura adhibeatur oris ventriculi, maxime ne sit relaxatum nimis; quia plus dominatur illa pars super affectus, præsertim quotidianos, quam aut cor aut cerebrum; exceptis tantummodo iis quæ fiunt per potentes vapores, ut in ebrietate et melancholia.

99. De operatione super spiritus, ut juveniles maneant et revirescant, hæc inquisita sunt: quod eo diligentius præstitimus, quod de his operationibus, potiori ex parte, magnum est apud medicos et alios auctores silentium: maxime autem, quia operatio super spiritus eorumque recrudescentiam ad prolongationem vitæ est via maxime proclivis et compendiaria: propter duplex scilicet compendium; alterum, quod spiritus compendio operetur super corpus; alterum, quod vapores et affectus compendio operentur super spiritus; adeo ut hæc finem petant quasi in linea recta; cætera magis per circuitum.

II.

OPERATIO SUPER EXCLUSIONEM AËRIS.

Historia.

1. Exclusio aëris ambientis ad diuturnitatem vitæ dupliciter innuit. Primo, quod maxime omnium, post spiritum innatum, aër extrinsecus (utcunque spiritum humanum quasi animet, et ad sanitatem plurimum conferat) succos corporis deprædatur, et desiccationem corporis accelerat; itaque exclusio aëris ad longitudinem vitæ confert.

2. Alter effectus qui sequitur exclusionem aëris, subtilior multo est et profundior; scilicet quod corpus occlusum et non perspirans spiritum inclusum detinet, et in duriora corporis vertit; unde spiritus ea emollit et intenerat.

3. Hujus rei explicata est ratio in desiccatione inanimatorum; atque est axioma quasi infallibile, quod spiritus emissus corpora desiccat, detentus colliquat et intenerat: atque illud insuper simul assumendum, quod calor omnis proprie attenuat et humectat, et per accidens tantum contrahit et desiccat.

4. Vita in antris et speluncis, ubi aër non recipit radios solis, possit facere ad longævitatem; aër enim per se ad prædationem corporis non multum potest, nisi calore excitatus. Certe si quis memoriam rerum recolat, ex pluribus reliquiis et monumentis constare videtur, fuisse hominum magnitudines et sta-

turas longe iis quæ postea fuerunt grandiores; ut in Sicilia et aliis nonnullis locis. Istiusmodi autem homines in speluncis plerunque ætatem degebant: atqui diuturnitas ætatis et amplitudo membrorum habent nonnihil commune. Etiam antrum Epimenidis inter fabulas ambulat. Suspicor etiam vitam anachoretarum columnarium simile quippiam fuisse vitæ in antris; quippe ubi radii solis parum penetrabant, neque aër magnas mutationes aut inæqualitates recipere poterat. Illud certum, utrunque Simeonem Stylitam, et Danielem, et Sabam, atque alios anachoretas columnares, admodum longævos fuisse.[1] Etiam anachoretæ moderni, intra muros aut columnas septi et clausi, longævi sæpius reperiuntur.

5. Proxima vitæ in antris est vita in montibus. Quemadmodum enim in antra calores solis non penetrant; ita in fastigiis montium, reflexione destituti, parum possunt. Accipiendum autem hoc est de montibus ubi aër limpidus est et purus; scilicet ubi propter ariditates vallium nebulæ et vapores non ascendunt; quod fit in montibus qui Barbariam cingunt; ubi etiam hodie vivunt sæpenumero ad annos centum et quinquaginta, ut jam antea notatum est.

6. Atque hujusmodi aër, antrorum aut montium, ex sua natura propria parum aut nihil deprædatur: at aër qualis est noster, cum sit propter calores solis prædatorius, quantum fieri potest a corpore est excludendus.

7. Aër vero prohibetur et excluditur duobus modis: primo, si claudantur meatus; secundo, si oppleantur.

8. Ad clausuram meatuum faciunt, ipsius aëris frigiditas; nuditas cutis, ex qua illa induratur; lavatio in frigida; astringentia cuti applicata, qualia sunt mastyx, myrrha, myrtus.

9. Multo magis huic operationi satisfiet per balnea, sed raro usurpata (præsertim temporibus æstivis), quæ constent ex aquis mineralibus astringentibus, quæ tuto exhiberi possunt; quales sunt chalybeatæ et vitriolatæ; hæ enim cutem potenter contrahunt.

10. Quod ad oppletionem attinet; pigmenta, et hujusmodi spissamenta unctuosa, atque (quod commodissime in usu potest

[1] Simeon Stylites the elder spent more than eighty years on the tops of columns, and lived in all more than a hundred. (See Baron. an. 460, 17.) The younger spent more than sixty-eight years on two columns. (See Evagrius, Eccles. Hist. vi. 23.) Daniel, a disciple of the elder Simeon, "octogenarius in hâc vitâ decessit." (Baron. an. 489, 5.) Sabas, abbot of Matale in Cappadocia, died aged ninety-two, in 531. (See Baron. Martyr. Roman. Dec. 5. and Annal. 530 and 531.); but he was not a stylite.

esse) oleum et pinguia, non minus corporis substantiam conservant, quam pigmenta in oleo et vernix ligna.

11. Britones antiqui corpus glasto pingebant, et fuerunt admodum longævi; quemadmodum et Picti, qui inde etiam nomen traxisse a nonnullis putantur.[1]

12. Hodie se pingunt Brasilienses et Virginienses, qui sunt (præsertim illi priores) admodum longævi; adeo ut quinque abhinc annis Patres Galli nonnullos convenerint, qui ædificationem Fernamburgi, annis abhinc centum et viginti, ipsi ad tunc virilis ætatis, meminissent.[2]

13. Joannes de Temporibus, qui dicitur ad trecentesimum annum ætatem produxisse, interrogatus quomodo se conservasset, respondisse fertur, *Extra, oleo; intus, melle.*[3]

14. Hiberni, præsertim sylvestres, etiam adhuc sunt valde vivaces; certe aiunt, paucis abhinc annis comitissam Desmondiæ vixisse ad annum centesimum quadragesimum, et ter per vices dentiisse. Hibernis autem mos est se nudos ante focum butyro salso et veteri fricare et quasi condire.

15. Iidem Hiberni in usu habuerunt lintea et indusia croceata[4]; quod licet ad arcendam putrefactionem introductum fuerat, tamen (utcunque) ad vitæ longitudinem utile fuisse existimamus: nam crocus, ex omnibus quæ novimus, ad cutem

[1] Legis in his work on Runes has suggested the idea that not only the Picts, but the Britons also derived their name from this practice. He connects, probably fancifully, the root *brit* with that of the verb *to write*, remarking that, as we see in Greek, the ideas of writing and painting are cognate.

[2] This statement, although doubtless resting on the authority of the Jesuit Fathers, appears to be at variance with chronology. It is true that Cabral took possession of Brasil on behalf of the Crown of Portugal as early as 1500, and that on Easter Sunday in that year he erected a stone cross where Quarto Seguro now stands. But neither that town nor any other appears to have been founded until at least thirty years later, after the division of the country into captaincies. In that of Pernambuco, Olinda was the first founded; and as the native name of its site was given to the captaincy of which it was the capital, it is doubtless to it that Bacon here refers. That its foundation should have been remembered by several persons among those whom the missionaries met with ninety years afterwards is quite credible; but the story as it stands is at least exceedingly improbable. That the climate of Brazil favours longevity was long believed, and may perhaps be true. The notion is mentioned in Bacon's essays.

[3] This answer was originally given to Democritus (see the *Geoponica*, xv. 7. 6.); afterwards, with a slight modification, to Pollio Romilius. [See suprà, note p. 146.] I do not know by whom it is ascribed to the mythical Johannes de Temporibus.

[4] Spenser mentions these habits of the Irish among the customs which he supposes them to have derived from Spain, for no other reason, apparently, than that they appear to him to be suitable to a warm climate. It is worthy of remark that Campion, writing about a quarter of a century earlier, affirms that the Irish had given up the use of saffron, and were learning to wash their linen. However the custom was retained in some parts of the country not only after Campion's time, but till a much later period.

et confortationem carnis est res optima; cum et notabiliter astringat, et habeat insuper oleositatem et calorem subtilem sine ulla acrimonia. Equidem memini quendam Anglum, ut vectigalia supprimeret, croci saccum cum transfretaret circa stomachum portasse, ut lateret; eumque, cum antea ex mari gravissime ægrotare solitus esset, optime tunc valuisse, nec nauseam ullam sensisse.

16. Hippocrates jubet vestes ad cutem hieme puras portare, æstate sordidas et oleo imbutas[1]; hujus ratio videtur, quod per æstatem spiritus exhalant maxime; itaque pori cutis opplendi sunt.

17. Ante omnia igitur usum olei, vel olivarum, vel amygdalini dulcis, ad cutem ab extra ungendam, ad longævitatem conducere existimamus; eaque unctio debet fieri singulis auroris cum exitur e lecto, cum oleo in quo admisceatur parum salis nigri et croci. Unctio autem levis debet esse, ex lana aut spongia molliori, neque quæ stillet super corpus, sed cutem tantum intingat et inficiat.

18. Certum est liquores in majori quantitate, etiam oleosos, haurire nonnihil ex corpore: sed contra, parva quantitate, imbibi a corpore: itaque levis aspersio facienda est, ut diximus; aut plane indusium ipsum oleo liniendum est.

19. Objici vero forte possit, istam unctionem ex oleo quam laudamus (licet apud nos in usu nunquam fuerit, atque apud Italos in desuetudinem abierit) olim quidem apud Græcos et Romanos familiarem fuisse et diætæ partem; neque tamen iis sæculis homines magis fuisse longævos. Sed respondetur rectissime; oleum in usu fuisse tantum post balnea, nisi forte inter athletas; balnea autem ex calido operationi nostræ tanto contraria sunt, quanto unctiones congruæ; cum alterum meatus aperiat, alterum obstruat. Itaque balneum absque unctione sequenti pessimum; unctio absque balneo optima. Etiam ad delicias potius adhibebatur ista unctio, atque (si in optimam partem accipias) ad sanitatem; sed nullo modo in ordine ad vitam longævam; itaque simul adhibebantur unguenta pretiosa, quæ ad delicias grata, ad nostram intentionem noxia sunt, ob calorem; ut bene dixisse videatur Virgilius:

Nec casia liquidi corrumpitur usus olivi.[2]

[1] Hippocr. De salubri Diætâ. See note on *Sylva Sylvarum*, § 55. —*J. S.*
[2] Georg. ii. 466.

20. Inunctio ex oleo, et hieme confert ad sanitatem, per exclusionem frigoris; et æstate, ad detinendos spiritus et prohibendam exolutionem eorum, et arcendam vim aëris, quæ tunc maxime est prædatoria.

21. Cum inunctio ex oleo operatio sit ad vitam longam fere potentissima, visum est addere cautiones, ne periclitetur valetudo: eæ quatuor sunt, secundum quatuor incommoda quæ exinde sequi possint.

22. Primum incommodum est, quod reprimendo sudores morbos inducere possit ex humoribus illis excrementitiis: huic remedium adhibendum est ex purgationibus et clysteriis, ut evacuationi debite consulatur; certum enim est evacuationem per sudores sanitati plerunque conferre, longitudini vitæ officere. Purgativa autem moderata in humores agunt, non in spiritus, quod facit sudor.

23. Secundum incommodum est, quod corpus calefacere possit, et subinde inflammare; spiritus enim occlusus nec perspirans, ferventior est: huic incommodo occurritur, si dieta ut plurimum vergat ad frigidum, et sumantur propria quædam ad refrigerandum per vices: de quibus mox in operatione super sanguinem inquiremus.

24. Tertium est, quod caput gravare possit; omnis enim oppletio extrinsecus repercutit vapores, et eos mittit versus caput: huic incommodo omnino occurritur per cathartica, præsertim clysteria; et claudendo os ventriculi fortiter cum stypticis; et pectendo et fricando caput, etiam cum lixiviis idoneis, ut aliquid exhalet; et non omittendo exercitationem bonam et qualem convenit, ut etiam per cutem nonnihil perspiret.

25. Quartum incommodum subtilius est malum; videlicet quod spiritus, detentus per clausuram pororum, videatur posse seipsum nimis multiplicare; quia cum parum evolet, et continuo spiritus novus generetur, nimium increscit spiritus, et sic corpus etiam plus prædari possit: verum hoc non prorsus ita se habet; nam spiritus omnis conclusus hebes fit (quandoquidem ventiletur motu spiritus, ut et flamma), ideoque minus activus est, et minus sui generans; calore certe auctus (ut et flamma) sed motu piger: sed et huic incommodo remedium adhiberi possit a frigidis oleo quandoque admistis; qualia sunt rosa et myrtus; nam calidis omnino abstinendum, ut dictum est de casia.

26. Neque inutilis est applicatio ad corpus vestium quæ et ipsæ in se habent aliquid unctuosi sive oleosi, non aquosi; illæ enim exhaurient corpus minus; quales sunt ex lana, potius quam ex lino: certe manifestum est in spiritibus odorum, quod si ponas pulveres odoratos inter lintea, multo citius virtutem perdunt, quam inter lanea. Itaque lintea tactu et munditie jucunda, sed ad nostram operationem suspecta.

27. Hiberni sylvestres, cum incipiunt ægrotare, nihil prius faciunt quam ut lintea e stratis tollant, et in laneis pannis se convolvant.

28. Referunt nonnulli, se magno sanitatis suæ commodo laneis carmosinis [1], proxime ad cutem, sub indusiis suis, usos fuisse, tam ad braccas, quam ad corporalia.

29. Est et illud observandum, aërem corpori assuetum minus illud deprædari, quam novum et subinde mutatum: itaque pauperes, qui in tuguriis suis intra proprios lares perpetuo vivunt, nec sedes mutant, sunt plerunque longæviores: veruntamen quoad alias operationes mutationem aëris (præsertim spiritibus non omnino inertibus) utilem esse judicamus; mediocritas autem adhibenda foret, quæ utrinque satisfaciat; illud fiet, si quatuor temporibus anni fiet per stata tempora mutatio loci ad sedes idoneas; neque sint corpora aut in peregrinatione nimia, aut in statione. Atque de operatione per exclusionem aëris, et de evitanda vi ejus prædatoria, hæc dicta sint.

III.

OPERATIO SUPER SANGUINEM ET CALOREM SANGUIFICANTEM.

Historia.

1. Operationes duæ sequentes sunt operationibus duabus præcedentibus tanquam antistrophæ; atque iis respondent, quemadmodum passiva activis; præcedentes enim duæ id agunt, ut spiritus et aër actionibus suis sint minus deprædantes; hæ vero, ut sanguis et succus corporis sint minus deprædabiles. Quoniam vero sanguis est irrigatio succorum et membrorum, et præparatio ad ea; operationem super sanguinem primo loco collocamus. Circa hanc operationem proponemus consilia numero pauca, sed vi valde efficacia: ea tria sunt.

[1] So in the original, and again p. 188. l. 19. In both places *carminatis* is silently substituted in Blackbourne's edition.—*J. S.*

2. Primo dubium non est, quin si sanguis sit aliquanto frigidior, minus futurus sit dissipabilis: quoniam vero quæ per os sumuntur frigida, cum reliquis intentionibus haud paucis male conveniunt; ideo optimum foret alia invenire, quæ non sunt cum istiusmodi incommodis complicata. Ea duo sunt.

3. Alterum hujusmodi est; adducantur in usum, idque maxime in juventute, clysteria nihil omnino purgantia aut abstergentia, sed solummodo refrigerantia et nonnihil aperientia: probata sunt quæ fiunt ex succis lactucæ, portulacæ, hepaticæ, etiam sedi majoris, et mucilaginis seminis psyllii, cum decoctione aliqua temperata aperiente, admisto aliquanto caphuræ: verum vergente ætate, omittatur sedum majus et portulaca, et substituantur succi boraginis, et endiviæ, aut similium; atque retineantur clysteria hujusmodi quantum fieri potest, ad horam scilicet, aut amplius.

4. Alterum est ejusmodi; in usu sint, præsertim æstate, balnea aquæ dulcis et modice admodum tepidæ, prorsus absque emollientibus, malva, mercuriali, lacte, et similibus; adhibeatur potius serum lactis recens in nonnulla quantitate, et rosa.

5. Verum, quod caput rei est et novum, illud præcipimus; ut ante balneationem inungatur corpus cum oleo, cum spissamentis; ut qualitas refrigerii excipiatur, aqua magis arceatur, neque tamen meatus corporis nimium occludantur; etenim cum frigus exterius corpus fortiter occludit, tantum abest ut promoveat infrigidationem, ut etiam eam prohibeat, et irritet calorem.

6. Similis est usus vesicarum, cum decoctionibus et succis refrigerantibus, applicatis circa inferiorem regionem corporis, videlicet sub costas, usque ad pubem; nam et hoc est genus balneationis, ubi corpus liquoris ut plurimum excluditur, refrigerium tantum excipitur.

7. Restat tertium consilium, quod non ad sanguinis qualitatem, sed ad substantiam ejus pertinet; ut reddatur magis firma et minus dissipabilis, et in quam calor spiritus minus agere possit.

8. Atque de usu limaturæ auri, aut auri foliati, aut pulveris margaritarum, gemmarum, et coralli, et similium, hodie nihil credimus, nisi quatenus præsenti operationi satisfaciant: certe cum Arabes et Græci et moderni iis rebus tantas virtutes tribuerint, non omnino nihil videatur esse in istis, quæ tot homines experti observarunt. Itaque missis phantasticis circa

illas opinionibus, plane arbitramur, si universæ substantiæ sanguinis aliquid insinuari possit per minima, in quod spiritus et calor parum aut nihil agere possint, omnino id non tantum putrefactioni sed etiam arefactioni obstiturum, et ad vitam prolongandam fore efficacissimum. In hoc tamen plures adhibendæ sunt cautiones: primo, ut fiat admodum exacta comminutio; secundo, ut hujusmodi dura et solida sint omnis malignæ qualitatis expertia, ne cum in venis dispergantur et lateant, aliquid nocumenti inferant; tertio, ut nunquam sumantur cum cibis, nec ita excipiantur ut diu hæreant, ne generent periculosas obstructiones circa mesenterium; quarto, ut rarus sit eorum usus, ne coëant et cumulentur in venis.

9. Itaque modus excipiendi sit, stomacho jejuno, in vino albo, cui admistum sit parum olei amygdalini, et fiat corporis exercitatio super haustum eorum.

10. Simplicia autem quæ operationi huic satisfaciant, possint esse loco omnium, aurum, margaritæ, et corallus; metalla enim omnia, præter aurum, non sunt absque maligna qualitate in volatili ipsorum: neque etiam tam exquisite comminuuntur, quam aurum foliatum; gemmæ autem translucidæ, et tanquam vitreæ, minus nobis placent (ut et antea diximus) propter suspicionem corrosionis.

11. At nostro judicio et tutior et efficacior foret usus lignorum, in infusionibus et decoctionibus; satis enim in iis possit esse ad firmitudinem sanguinis, neque tamen simile periculum est ab obstructione: præcipue autem, quia possunt sumi in cibo et potu; unde facilius ingressum reperient in venas, nec deponentur in fæcibus.

12. Ligna ad hoc idonea sunt, santalum, quercus, et vitis; ligna enim calidiora, aut aliqua ex parte resinosa, rejicimus; possint tamen adjici caules siccæ et lignosæ roris marini; cum frutex sit rosmarinus et ætatem multarum arborum æquet; etiam hederæ caules siccæ et lignosæ, sed ea quantitate, ut saporem non reddant ingratum.

13. Sumantur vero ligna aut in jusculis decocta, aut infusa in mustum aut cervisiam, antequam sedeat; in jusculis autem (ut fit in guaiaco et similibus) semper infundantur diu antequam decoquantur, ut firmior pars ligni, et non tantum ea quæ leviter hæret, eliciatur: fraxinus autem, licet ad pocula adhibeatur, nobis suspecta est. Atque de operatione super sanguinem hæc inquisita sint.

IV.

OPERATIO SUPER SUCCOS CORPORIS.

Historia.

1. Duo sunt corporum genera (ut in inquisitione de inanimatis jam dictum est) quæ difficilius consumuntur; dura, et pinguia; ut cernitur in metallis et lapidibus, atque in oleo et cera.

2. Operandum itaque est, ut succus corporis sit subdurus; atque etiam ut sit subpinguis, aut subroscidus.

3. Quatenus ad duritiem, ea efficitur tribus modis: natura alimenti firma; frigore condensante cutem et carnes; et exercitatione succos fermentante et compingente, ne sint molles et spumosi.

4. Quatenus ad naturam alimenti, talis esse debet ut sit minus dissipabilis; qualia sunt caro bovina, caro suilla, caro cervina, etiam caro caprearum, hœdorum, cygnorum, et anserum, et palumbium sylvestrium, (præsertim si hujusmodi carnes fuerint modice salitæ), pisces itidem saliti et sicci; etiam caseus subvetus, et hujusmodi.

5. Quoad panem autem, avenaceus, aut etiam paululum pisatus, aut secalicius, aut hordeaceus, solidior est quam ex frumento; atque etiam in pane frumentaceo, solidior qui paulo plus habet ex furfure, quam qui purioris est pollinis.

6. Orcades, qui piscibus vescuntur salitis, atque generaliter icthyophagi, longævi sunt.

7. Monachi et eremitæ, qui parce et sicco alimento pascebantur, fuerunt ut plurimum longævi.

8. Etiam aqua pura, in potu frequenter usurpata, reddit succos corporis minus spumosos; cui si, propter spiritus hebetudinem (qui proculdubio in aqua est parum penetrativus), admisceatur aliquid nitri, utile esse existimamus. Atque de firmitudine alimenti hactenus.

9. Quatenus ad condensationem cutis et carnium per frigus, vivaciores fere sunt qui sub dio vivunt, quam qui sub tecto; atque qui in regionibus frigidis, quam qui in calidis.

10. Vestes nimiæ, sive in lectis, sive portatæ, corpus solvunt.

11. Lavatio corporis in frigida, bona ad longitudinem vitæ;

usus balneorum tepidorum malus; de balneis autem ex aquis astringentibus mineralibus superius dictum est.

12. Quatenus ad exercitationem; vita otiosa manifesto reddit carnes molles et dissipabiles, exercitatio autem robusta (modo absint nimii sudores aut lassitudines) duras et compactas: etiam exercitatio intra aquas frigidas, qualis est natatio, valde bona; atque generaliter exercitatio sub dio, melior quam sub tecto.

13. De fricationibus (quod est exercitationis genus) tamen quia alimenta magis evocant quam indurant, postea suo loco inquiremus.

14. Jam vero cum de duritie succorum dictum sit, veniendum ad oleositatem sive roscidationem ipsorum; quæ perfectior et potentior est intentio, quam induratio; quia non habet incommodum, neque malum complicatum: omnia enim quæ ad duritiem succorum pertinent, ejusmodi sunt, ut cum alimenti absumptionem prohibeant, etiam ejusdem reparationem impediant; unde fit ut diuturnitati vitæ eadem et prosint et obsint; at quæ ad roscidationem succorum pertinent, ex utraque parte juvant; cum reddant alimentum et minus dissipabile et magis reparabile.

15. Cum vero dicimus, quod succus corporis debeat fieri roscidus et pinguis, notandum est, hoc nos non intelligere de pinguedine aut adipe manifesto, sed de rore perfuso, et (si placet) radicali, in ipsa corporis substantia.

16. Neque rursus existimet quispiam oleum, aut pinguia ciborum, aut medullas, similia sibi generare, atque intentioni nostræ satisfacere; neque enim quæ perfecta semel sunt, retro aguntur; sed talia debent esse alimenta, quæ post digestionem et maturationem tum demum oleositatem in succis ingenerent.

17. Neque rursus existimet quispiam, oleum et pingue coacervatum et simplex difficilis esse dissipationis, in mistione autem non eandem retinere naturam; etenim quemadmodum oleum per se multo serius consumitur quam aqua, ita etiam in papyro aut sudario diutius hæret, et tardius desiccatur; ut prius notavimus.

18. Ad irrorationem corporis melius faciunt cibi assati, aut furno cocti, quam elixi: atque omnis præparatio ciborum cum aqua incommoda est; quinetiam et oleum copiosius elici videmus ex corporibus siccis quam ex humidis.

19. Generaliter ad irrorationem corporis prodest multus usus dulcium, sacchari, mellis, amygdalarum dulcium, pinearum, pistaciorum, dactylorum, uvarum passarum, uvarum Corinthi, ficuum, et hujusmodi: contra omnia acida, et nimium salsa, et nimium acria, sunt generationi succi roscidi opposita.

20. Neque Manichæis eorumque diætæ[1] favere existimabimur, si semina quæque et nucleos et radices in cibis aut eorum condimentis frequentia esse debere dicamus; quandoquidem omnis panis (panis autem ciborum firmamentum est) aut ex seminibus est aut ex radicibus.

21. Ante omnia vero ad irrorationem corporis maxime facit natura potus, qui ciborum vehiculum est. Itaque in usu sint potus illi, qui absque omni acrimonia aut acedine subtiles tamen sint; quales sunt vina (ut ait anus apud Plautum) *vetustate edentula*[2], et cervisia ejusdem generis.

22. Hydromel (ut arbitramur) non foret malum, si fuerit forte et vetus; attamen quoniam omne mel habet aliquid acutum (ut patet ex acerrima illa aqua quam chymici ex eo extrahunt, quæ etiam metalla solvit), melius foret, si fieret similis potio ex saccharo, non infuso leviter, sed ita incorporato quemadmodum mel solet esse in hydromelite, et quæ habeat vetustatem anni aut sex mensium; unde aqua cruditatem deponat, et saccharum subtilitatem acquirat.

23. Atque vetustas vini aut potus hoc habet, quod subtilitatem generat in partibus liquoris, acrimoniam in spiritibus; quorum primum utile, secundum noxium; itaque ad hanc complicationem enodandam, mittatur in dolium, priusquam resederit nonnihil vinum a musto, caro suilla aut cervina bene cocta, ut habeant spiritus vini quod ruminent et mandant, atque inde mordacitatem suam deponant.

24. Similiter si recipiat cervisia non solum grana tritici, hordei, avenarum, pisarum, &c. sed etiam partem (puta tertiam) ex radicibus aut pulpis pinguibus (qualia sunt radices potado, medullæ artiplicis[3], radices bardanæ[4], aut aliæ radices dulces et esculentæ), utiliorem fore potum ad longævitatem existimamus, quam cervisiam ex granis tantum.

[1] Bacon seems to allude to the charges against the Manichæans to be found in Augustine's tract "Ad Quod vult Deus," *De Hæresibus*. The elect Manichæans lived chiefly on fruit and vegetables — the auditors had no peculiar diet. See Beausobre, Hist. des Manich. ii. p. 774. et infrà.

[2] Pœnulus, 569.

[3] Qu. *atriplicis*, (orage)? See Plin. xix. 6.— *J. S.*

[4] Burdock.

25. Etiam quæ in partibus suis valde tenuia sunt, et nihilominus nulla prorsus sunt acrimonia aut mordacitate, utilia sunt in condimentis ciborum; qualem virtutem inesse deprehendimus in paucis quibusdam ex floribus; floribus scilicet hederæ, qui in aceto infusi etiam gustui placent; floribus calendulæ[1], qui in usu sunt in brodiis; et floribus betonicæ. Atque de operatione super succos corporis hæc inquisita sunt.

V.

OPERATIO SUPER VISCERA AD EXTRUSIONEM ALIMENTI.

Historia.

1. Quæ viscera illa principalia (quæ concoctionis fontes sunt) stomachum, hepar, cor, cerebrum, ad functiones suas probe exercendas confortant (unde alimenta in partes distribuuntur, spiritus sparguntur, atque inde reparatio corporis totius transigitur), a medicis atque eorum descriptis et consiliis petenda sunt.

2. De splene, felle, renibus, mesenterio, iliis, et pulmonibus, non loquimur; sunt enim membra ministrantia principalibus; atque cum de sanitate tractatur, in considerationem vel præcipuam quandoque veniunt; quia patiuntur singula suos morbos, qui nisi curentur, etiam in viscera principalia incurrunt: quatenus vero ad prolongationem vitæ et reparationem per alimenta et retardationem atrophiæ senilis, si concoctiones et principalia illa viscera bene se habeant, cætera maxima ex parte ad votum sequentur.

3. Atque ex medicorum libris qui de quatuor membrorum principalium confortatione et commodis sermones faciunt, decerpenda sunt ea unicuique quæ pro ratione status corporis proprii in diætam et regimen vitæ transferri poterint: etenim sanitas medicinis temporalibus plerunque indiget; at diuturnitas vitæ ex victus ratione, et constanti medicinarum juvantium serie, speranda est. Nos vero pauca, eaque selecta et optima, proponemus.

4. Stomachum (qui, ut aiunt, est paterfamilias, et cujus robur

[1] Marigold. Montaigne has recorded his obligations to certain ladies who, when he was suffering from stone or gravel, supplied him with marigold broth. He seems however to have disdained to avail himself of their kindness.

ad reliquas concoctiones est fundamentale) ita munire decet et confirmare, ut sit absque intemperie calidus; deinde astrictus, non laxus; etiam mundus, non humorum fastidiis oppressus; et nihilominus (cum ex seipso, potius quam ex venis, nutriatur) minime prorsus inanis aut jejunus; postremo in appetitu servandus est, quia appetitus digestionem acuit.

5. Miramur quomodo illud *calidum bibere* (quod apud antiquos in usu fuit) in desuetudinem abierit; novimus certe medicum admodum celebrem, qui in prandio et cœna jusculum etiam præcalidum avide ingerere solebat, et paulo post optare ut regestum esset; Neque enim mihi jusculo opus est (inquit) sed calido tantum.

6. Omnino utile arbitramur primam potionem, sive vini sive cervisiæ sive potus alterius (cui quis insuevit), in cœna semper calidam exhiberi.

7. Vinum extinctionis auri utile arbitramur semel in mensa; non quod aurum aliquid virtutis ad hoc largiri credamus, sed quia extinctionem omnem metallicam in aliquo liquore astrictionem potentem indere novimus: aurum autem deligimus, quia præter illam (quam optamus) astrictionem, nil aliud metallicæ impressionis post se relinquit.

8. Offas panis in vino, media mensa, utiliores quam ipsum vinum esse judicamus; præsertim si vino, cui offa intingatur, ros marinus et cortex citri fuerint infusi; idque cum saccharo, ut tardius labatur.

9. Usum cotoneorum ad stomachi robur utilem esse certum est: melius tamen adhiberi judicamus in succis depuratis cum saccharo (quos *myvas* vocant), quam in carnibus ipsorum; quia stomachum nimis gravant: illæ vero myvæ[1] post mensam simplices, at ante mensam cum aceto, utilissime sumuntur.

10. Utilia stomacho sunt præ cæteris simplicibus, ros-marinus, enula, mastix, absinthium, salvia, mentha.

11. Pilulas ex aloë, et mastice, et croco, præsertim temporibus hiemalibus, ante prandium sumptas, probamus; ita tamen ut aloë non tantum succo rosarum multis vicibus abluta sit, sed etiam in aceto (in quo dissolutum fuerit tragacanthum), et postea in oleo amygdalino dulci et recenti, ad aliquot horas macerata sit, antequam formetur in pilulas.

12. Vinum aut cervisia infusionis absinthii, cum modico

[1] Myvæ are apparently conserves.

enulæ et santali citrini[1], recte per vices adhibetur; atque hoc hieme potius.

13. At æstate, haustus ex vino albo, cum aqua fragariæ diluto, in quo vino pulveres exquisiti perlarum et testarum cancrorum fluviatilium, et (quod mirum fortasse videatur) parum cretæ, fuerint infusa, stomachum optime recreat et roborat.

14. At generaliter omnis haustus matutinus (quales frequenter in usu sunt) refrigerantium (succorum, decoctionum, seri lactis, hordeatorum, et similium) fugiendus est; nihilque prorsus immittendum stomacho jejuno, quod sit frigidum purum. Melius exhibebuntur res hujusmodi (si necessitas postulet) vel hora quinta post prandium, vel hora una post leve jentaculum.

15. Jejunia frequentia mala sunt ad longævitatem; quinetiam sitis quæcunque evitanda, et servandus stomachus satis mundus, sed perpetuo quasi humidus.

16. Oleum olivarum recens et bonum in quo Mithridatii nonnihil dissolutum fuerit, inunctum spinæ dorsi ex adverso oris stomachi, stomachum mirum in modum confortat.

17. Sacculus ex floccis carmosinis, infusis in vinum austerum, in quod infusa fuerint myrtus et cortex citri et parum croci, super stomachum perpetuo gestari potest. Atque de stomachum confortantibus hactenus; cum etiam haud pauca ex his, quæ aliis operationibus inserviunt, ad hoc etiam juvent.

18. Jecori, si a torrefactione sive desiccatione atque ab obstructione immune servetur, nil ultra opus est: etenim exolutio illa quæ aquositates generat morbus prorsus est; at reliqua duo etiam senectus obrepens inducit.

19. Huc pertinent vel maxime ea quæ in operatione super sanguinem descripta sunt; iis adjiciemus pauca admodum, sed electa.

20. Præcipue in usu sit vinum granatorum dulcium; aut si illud haberi non possit, succus ipsorum recens expressus; mane sumendus, cum aliquanto sacchari, et immisso in vitrum (in quod fit expressio) modico corticis citri recentis, et garyophyllis tribus aut quatuor integris: hocque usurpetur a Februario ad finem Aprilis.

21. In usum adducatur, ante alias omnes herbas, nasturtium; sed tamen pubescens, non vetus; usurpetur sive crudum, sive in jusculis, sive in potu; et post hanc cochlearia.

[1] Yellow sandal wood.

22. Aloë, quocunque modo abluta aut correcta, hepati noxia; itaque nunquam familiariter sumenda est. Rhubarbarum contra vitale hepati, modo tres adhibeantur cautiones: primo, ut sumatur ante cibum, ne desiccet nimis, aut vestigium stypticitatis relinquat: secundo, ut maceretur ad horam unam aut duas in oleo amygdalino recenti, cum aqua rosacea, antequam alias infundatur, aut detur in substantia: tertio, ut vicibus alternis sumatur, alias simplex, alias cum tartaro, aut parum salis nigri, ne leviora tantum asportet, et reddat massam humorum magis obstinatam.

23. Vinum aut decoctum aliquod chalybeatum, ter aut quater in anno sumi probo, ad obstructiones potentiores solvendas; ita tamen ut semper præcedat haustus duorum aut trium cochlearium olei amygdalini dulcis recentis, et sequatur motus corporis, præsertim brachiorum et hypochondriorum.

24. Liquores dulcorati, idque cum pinguedine quadam, ad arcendam arefactionem et salsedinem et torrefactionem et denique senilitatem jecoris præcipue et plurimum possunt; præsertim si per vetustatem bene incorporentur; tales fiant ex fructibus et radicibus dulcibus; scilicet vina et potus ex uvis passis recentibus, jujubis, caricis, dactylis, pastinacis, bulbis sive potadis, et hujusmodi, cum admistione lycoritiæ[1] quandoque; etiam potus ex granis Indicis (quæ *mayz* vocant), cum mixtura dulcium, plurimum confert. Notandum est autem, intentionem præservationis jecoris in mollitie quadam et pinguedine longe potentiorem esse illa altera quæ pertinet ad apertionem jecoris; quæ potius innuit ad sanitatem quam ad diuturnitatem vitæ; nisi quod obstructio ea quæ inducit torrefactionem, æque malitiosa est ac aliæ arefactiones.

25. Radices cichoreæ, spinachiæ, betæ, a medullis purgatas, atque ad teneritudinem coctas in aqua, cum tertia parte vini albi, pro condimentis familiaribus cum oleo et aceto, laudo; etiam gemmas sive caules asparagi, pulpas artiplicis[2], et radices bardanæ, debitis modis elixas et conditas; et juscula (tempore veris) ex foliis pubescentibus vitium, et herba viridi tritici. Atque de jecore muniendo hactenus.

26. Cor juvamentum suscipit maxime, atque nocumentum,

[1] So in the original. *Glycyrrhizæ* (which is no doubt the classical form of the word) is substituted in Blackbourne's edition. — *J. S.*

[2] Artichoke? [Qu. see p. 185. note 3. — *J. S.*]

ex aëre quem spiramus; ex vaporibus; atque ex affectibus: atque complura ex iis, quæ de spiritibus supra dicta sunt, huc transferri possunt; indigesta autem moles cordialium apud medicos ad intentionem nostram parum valet; attamen quæ venenorum malignitati occurrere deprehenduntur, ea demum ad muniendas cordis vires sano cum judicio adhiberi possunt; præsertim si sint ex eo genere, quod non tam propriam veneni naturam frangat, quam cor et spiritus in venenum insurgere faciat. Atque de cordialibus consule tabulam superius positam.

27. Aëris bonitas in locis experientia potius dignoscitur, quam signis. Optimum judicamus aërem spirare in locis æquis et planis, atque ex omni parte perflatilibus; si fuerit terra sicca, neque tamen prorsus arida, aut arenosa; quæque emittat serpillum et amaraci genus, et hinc inde caules mentæ campestris; quæque sit non prorsus rasa, sed arboribus nonnullis (ad umbram) sparsim consita; atque ubi rosa rubi spiret aliquid muscatellum et aromaticum: flumina si adsint, nocere potius arbitramur, nisi fuerint exigua admodum, et limpida, et glareosa.

28. Aërem matutinum certum est vespertino esse magis vitalem, licet ad delicias alter magis ametur.

29. Aërem a vento agitatum paulo leniore, aëre cœli sereni fœliciorem esse arbitramur: optimus autem est Zephyrus matutinus, et Boreas postmeridianus.

30. Odores ad confortationem cordis præcipue utiles sunt; neque tamen ac si odor bonus esset aëris boni prærogativa. Certum enim est, quemadmodum inveniuntur aëres prorsus pestilentes, qui non tantum fœtent quantum alii minus noxii, similiter inveniri e contra aëres saluberrimos et spiritibus amicissimos, qui aut prorsus sint inodori aut ad sensum minus grati et fragrantes. Atque omnino, ubi degitur in aëre bono, odores per vices tantum repeti debent: odor enim continuus (licet optimus) spiritus nonnihil onerat.

31. Laudamus ante omnes alios (ut etiam superius innuimus) odores ex plantis vegetantibus et non avulsis, in aëre aperto exceptis; quales sunt ex violis, floribus garyophylli (tam majoris quam minoris), floribus fabarum, floribus tiliæ, floribus sive pulvisculo vitium, floribus madre-selve, floribus parietariæ luteæ; rosa muscatella (nam cæteræ rosæ germinantes parce emittunt odores), fragaria (præsertim moriente), rubo suavi (præcipue ineunte vere), mentha campestri, lavendula florente; atque in regionibus calidioribus, malo arantio, citrio; myrto,

lauro: itaque ambulatio aut sessio inter hujusmodi auras in usu esse debet.

32. Ad cordis juvamentum, odores refrigerantes calidioribus anteponimus; suffitus itaque matutinus, aut sub calores meridiei, optimus fuerit, ex æquis portionibus aceti, aquæ rosaceæ, et vini generosi, super laminam ferri quasi candentem fusorum.

33. Neque vero Matri Telluri libare nos quis existimet, si præcipiamus inter fodiendum aut terram vertendam vinum generosum superinfundi.

34. Aquam e floribus arantiorum bonam, cum modica parte aquæ rosaceæ et vini fragrantis, etiam per nares attrahi, aut per syringem errhini more immitti, (sed rarius) bonum est.

35. At masticatio (quamvis non habeamus betel), et detentio in ore eorum quæ spiritus fovent (licet assidua) utilis admodum est. Fiant itaque grana aut pusilli pastilli ex ambra, et musco, et ligno aloës, et ligno Rhodio, et radice iridis, et rosa: atque formentur illa grana aut pastilli per aquam rosaceam, quæ per paululum balsami Indi transierit.

36. Vapores vero qui ex rebus intro sumptis cor muniunt et fovent, hæc tria habere debent; ut sint amici, clari, et refrigerantes. Caliditas enim vaporum mala; atque ipsum vinum, quod putatur habere vaporem solummodo calefacientem, non expers est prorsus qualitatis opiatæ. Claros autem vapores vocamus eos, qui plus habent ex vapore quam ex exhalatione, neque sunt omnino fumei aut fuliginosi aut unctuosi, sed humidi et æquales.

37. Inter turbam inutilem cordialium pauca ad diætam in usu esse debent; loco omnium, ambragrisia, et crocus, et granum kermes, ex calidioribus; atque radices buglossi et boraginis, atque mala citria, et limones dulces, et poma fragrantia, ex frigidioribus. Etiam eo (quo diximus) modo, et aurum et margaritæ, non tantum intra venas, sed etiam in transitu et circa præcordia, aliquid possunt; per refrigerium scilicet, absque aliqua noxia qualitate.

38. De lapide bezoar, ob multas probationes, virtuti ejus fidem non prorsus derogamus; sed omnino modus ejus sumptionis talis esse debet, ut facillime virtus ejus communicetur spiritibus. Itaque nec in jusculis, nec in syrupis, nec in aqua rosacea, aut hujusmodi, usum ejus probamus; sed tantum in vino, aut aqua cinnamomi, aut hujusmodi distillato, sed tenui, non calido aut forti.

39. De affectibus jam superius inquisitum est: illud tantum adjicimus, omne desiderium magnum et constans, et (ut loquuntur) *heroicum*, cordis virtutes roborare et ampliare: atque de corde hactenus.

40. Ad cerebrum quod attinet (ubi cathedra et universitas spirituum animalium residet), quæ superius inquisita sunt de opio et nitro et subordinatis ad ipsa, et de conciliatione somni placidi, etiam huc aliquatenus spectant. Illud quoque certum, cerebrum tanquam in tutela stomachi esse; ideoque quæ stomachum confortant et muniunt, cerebrum per consensum juvant, atque huc similiter transferri debent. Adjiciemus pauca, tria externa, internum unum.

41. Balneationem pedum omnino in usu esse volumus, ad minus, semel in septimana; balneumque fieri ex lixivio, cum sale nigro, et salvia, camomilla[1], fœniculo, samsucho, et costo, cum foliis angelicæ viridis.

42. Suffitum laudamus etiam quotidianum mane ex roremarino arido, ramulis lauri siccis, et ligno aloës; nam gummi suavia caput gravant.

43. Cavendum prorsus, ne capiti per exterius admoveantur calida; qualia sunt aromata, non excepta nuce muscata: etenim calida illa ad plantas pedum præcipitamus, ibique solum applicari volumus. Unctionem vero capitis levem ex oleo, cum rosa et myrto et parum salis et croci, laudamus.

44. Memores eorum quæ de opiatis et nitro et similibus ante proposuerimus, quæ spiritus tantopere densant, non existimamus abs re fore, si semel diebus quatuordecim accipiantur in brodio matutino grana tria vel quatuor castorei, cum modico seminis angelicæ et calami aromatici; quæ et ipsa cerebrum roborant, et in densitate substantiæ spirituum (quæ ad vitæ longævitatem tam necessaria est) motus vivacitatem et vigorem excitant.

45. In confortativis quatuor viscerum principalium, ea proposuimus, quæ et propria sunt, atque electa, atque in diætam et regimen vitæ transferri tuto et commode possunt: varietas enim medicamentorum ignorantiæ filia est; neque *multa fercula* (quod aiunt) tam *multos morbos fecere*, quam *multa medicamenta paucas curas*. Atque de operatione super viscera principalia, ad extrusionem alimenti, hæc inquisita sunt.

[1] So in the original *Chamæmelo* is substituted in Blackbourne's edition; and this is no doubt the classical form of the word. But where the difference is more than one of orthography, I have thought it better to preserve the form adopted by Bacon.—*J. S.*

VI.

OPERATIO SUPER PARTES EXTERIORES AD ATTRACTIONEM ALIMENTI.

Historia.

1. Licet concoctio bona, per partes interiores facta, primas partes ad probam alimentationem teneat, tamen concurrere etiam debent actiones partium exteriorum; ut sicut facultas interior alimentum emittit et extrudit, ita facultas partium exteriorum idem arripiat et attrahat; quoque imbecillior fuerit facultas concoctionis, eo magis opus est auxilio concurrente facultatis attractivæ.

2. Attractio valida partium exteriorum excitatur præcipue per motum corporis, per quem partes calefactæ et confortatæ alimentum ad se alacrius vocant et attrahunt.

3. Illud vero maxime cavendum et prohibendum; ne idem motus et calor, qui ad membra novum succum evocat, membrum simul eo succo, quo antea perfusum erat, nimium exolvat.

4. Fricationes huic intentioni optime subserviunt, factæ præcipue mane; sed hoc perpetuo comitetur, ut post fricationem fiat levis inunctio cum oleo, ne attritio partium exteriorum eas per perspirationem reddat effœtas.

5. Proxima est Exercitatio, per quam partes ipsæ se confricant et concutiunt; modo sit moderata, et quæ (ut superius notatum est) nec sit celeris, nec ad ultimas vires, nec ad lassitudinem; verum in hac ipsa atque fricatione, eadem est ratio et cautio, ne corpus nimium perspiret: itaque exercitatio melior est sub dio quam sub tecto, et hieme quam æstate; atque insuper, exercitatio inunctione non tantum claudi debet, ut fricatio; sed etiam in exercitationibus vehementioribus adhibenda est unctio, et in principio et sub finem, more athletarum.

6. Ad exercitationem, ut quam minimum aut spiritus aut succos exolvat, utile est ut usurpetur stomacho non prorsus jejuno. Itaque ut exercitatio nec stomacho repleto (quod plurimum interest sanitatis) nec jejuno (quod non minus interest longitudinis vitæ) usurpetur, in usum adduci debet jentaculum mane, non ex medicamentis, aut haustibus matutinis, aut uvis passis, aut ficubus, aut hujusmodi; sed plane ex cibo et potu; at levi admodum et modica quantitate.

7. Exercitationes ad irrigationem membrorum debent esse membris omnibus quasi æquales; non ut (quemadmodum ait Socrates) tibiæ moveant, brachia quiescant[1], nec e contra; sed ut partes universæ ex motu participent; atque omnino ad vitam prodest, ut corpus nunquam diu in eadem positura permaneat; sed singulis semi-horis ad minus posituram mutet, præterquam in somno.

8. Quæ ad mortificationem usurpantur, ad vivificationem traduci possunt; nam et indusia setosa, et flagellationes, et omnis exteriorum vexatio, vim eorum attractivam roborat.

9. Urticationem commendat Cardanus, etiam ad melancholiam; verum de hac parum nobis compertum est; et suspecta nobis est illa, ne propter venenatam nonnullam qualitatem urticæ, serpigines usu frequenti inducat et mala cutis. Atque de operatione super partes exteriores ad attractionem alimenti, hæc inquisita sunt.

VII.

OPERATIO SUPER ALIMENTUM IPSUM AD INSINUATIONEM EJUSDEM.

Historia.

1. Reprehensio vulgaris de *multis ferculis* censorem potius decet, quam medicum; aut utcunque constantiæ sanitatis utilis esse potest, ad longitudinem vitæ noxia est; propterea quod mistura alimentorum varia et aliquantum heterogenea exitum reperit in venas et succos melius et alacrius, quam simplex et homogenea; cum insuper ad appetitum excitandum (qui acies est digestionis) plurimum possit. Itaque et mensam variam et mutationes subinde ciborum, pro temporibus anni aut alias, probamus.

2. Etiam illud de simplicitate ciborum absque condimentis, simplicitas judicii est; cum condimenta bona et bene electa sint præparationes ciborum saluberrimæ, atque tum ad sanitatem tum ad vitam conferant.

3. Videndum est, ut cum cibis durioribus conjungantur potus fortiores, et condimenta quæ penetrent et incidant; cum cibis contra facilioribus, potus tenues et condimenta pinguia.

4. Cum paulo ante monuerimus, ut prima potio in cœna

[1] Xen. Symp. ii. 17.

excipiatur calida; nunc addimus quod, ad præparationem stomachi, etiam semi-hora ante cibum bonus haustus potus (cui quisque maxime insuevit) calidus usurpetur; sed parum aromatizatus ad gratiam saporis.

5. Præparatio ciborum, et panis, et potuum, si bene et in ordine ad intentionem instituatur, magni est prorsus momenti; licet sit res mechanica, et sapiat culinam et cellam; cum tamen longe præstet fabellis de auro et gemmis et hujusmodi.

6. Humectatio succorum corporis per præparationem alimentorum humidam, puerilis res est; ad fervores morborum nonnihil facit; ad alimentationem vero roscidam omnino contraria est; itaque elixatio ciborum longe inferior est, ad intentionem nostram, assatione et coctione in furno et similibus.

7. Assatio debet fieri igne vivido, et celerius perfici; non igne lento et nimia mora.

8. Carnes omnes solidiores in usu esse debent non prorsus recentes, sed nonnihil salis expertæ; ex sale ipso autem in mensa eo minus sumi debet, aut nihil omnino. Sal enim alimento incorporatus magis valet ad distributionem, quam per se sumptus.

9. Debent in usum adduci macerationes et infusiones carnium variæ et bonæ in liquoribus idoneis, ante assationes; quemadmodum quandoque in usu sunt similia ante coctiones in furno, et in muriis aliquorum piscium.

10. At pulsationes et tanquam verberationes carnium antequam coquantur, haud parvam rem præstant: certe in confesso est et perdices et phasianos in aucupio, et damas et cervos in venatione occisos, (nisi fuerit ea fuga longior) gratiores esse etiam ad gustum. Pisces autem nonnulli flagellati et verberati evadunt meliores. Etiam pyra duriora et austera, atque alii nonnulli fructus, compressione dulcescunt.[1] Bonum esset in usum adduci carnium duriorum nonnullam pulsationem et contusionem, antequam ignem patiantur; idque ex optimis præparationibus erit.

11. Panis modice fermentatus, et valde parum salitus, optimus est; quique etiam in furno ferventi satis, nec admodum elanguido, coctus est.

12. Potus præparatio ad vitam longam simplici fere præcepto constat: atque de aquæ potoribus nihil attinet dicere; potest hujusmodi diæta (ut alibi diximus) vitam aliquandiu

[1] See Porta, Nat. Mag. xiv. 1.

remorari, sed nunquam majorem in modum prolongare: at in aliis potibus spirituosis, qualia sunt vinum, cervisia, hydromel, et hujusmodi, id tanquam summa summarum affectari et observari debet, ut partes liquoris sint subtilissimæ, et spiritus lenissimus: hoc vetustate simplici difficile erit efficere, quæ gignit partes paulo subtiliores, spiritus vero multo acriores; itaque de infusione in doliis substantiæ alicujus pinguis, quæ spirituum acrimoniam compescat, jam antea præceptum est: est et alius modus absque infusione aut mixtura; is est, ut liquor potus continuo agitetur, sive per vecturam in mari, sive per vecturam in carris, sive suspendendo utres ex funibus eosque quotidie agitando, aut aliis hujusmodi modis: certum enim est, motum illum localem partes subtilizare, ac spiritus in partibus interim ita fermentare, ut acedini (quod putrefactionis genus est) non vacent.

13. Vergente autem senectute, etiam talis præparatio ciborum instituenda est, quæ sit tanquam in media via ad chylum. Atque de distillationibus ciborum, meræ nugæ sunt; etenim portio nutritiva vel optima non ascendit in vaporem.

14. Incorporatio cibi et potus, antequam concurrant in stomacho, gradus est ad chylum; itaque sumantur vel pulli, vel perdices et phasiani, et similia; et coquantur in aqua cum parum salis; deinde mundentur et siccentur; postea sive in musto sive in cervisia fervescente infundantur, cum parum sacchari.

15. Etiam expressiones ciborum et concisiones minutæ, bene conditæ, senibus utiles sunt; eo magis quod officio dentium in manducatione (quod præparationis præcipuum genus est) fere destituantur.

16. Atque de juvamentis ejus defectus (dentium scilicet roboris, ad cibum molendum) tria sunt quæ conferre possint. Primum, ut alii dentes renascantur: id quod difficile omnino esse videtur, nec posse perfici absque instauratione corporis intima et potenti. Secundum est, ut mandibula per astringentia debita ita firmentur, ut officio dentium aliqua ex parte sufficere possint; quod non male cedere posse videtur. Tertium, ut cibus sit ita præparatus, ut ista masticatione non egeat; quod promptum est et expeditum.

17. Subit etiam cogitatio de quantitate cibi et potus, eam in excessu nonnullo quandoque ad irrigationem corporis utilem esse: tiaque et epulæ profusæ et perpotationes non omnino inhibendæ sunt. Atque de operatione super alimenta et eorundem præparationem hæc inquisita sunt.

VIII.

OPERATIO SUPER ACTUM ULTIMUM ASSIMILATIONIS.

Connexio.

De actu ultimo assimilationis (quem operationes tres proxime præcedentes intuentur) brevis et simplex erit præceptio; resque magis explicatione indiget, quam præceptione aliqua varia.

Commentatio.

1. Certum est corpora omnia assimilandi quæ in contiguo sunt desiderio nonnullo indui. Id faciunt generose et alacriter tenuia et pneumatica, veluti flamma, spiritus, aër: at contra, quæ molem habent crassam et tangibilem, debiliter admodum; eo quod desiderium illud assimilandi a fortiori desiderio quietis et se non movendi ligetur.

2. Certum est itidem, desiderium illud assimilandi, in mole corporea ligatum, ut diximus, et inutile redditum, a calore aut spiritu in proximo liberari nonnihil et excitari, ut tum demum actuetur; quæ unica est causa cur inanimata non assimilent, animata assimilent.

3. Certum et hoc quoque est; quo durior sit corporis consistentia, eo illud indigere majore calore ad stimulum assimilationis; quod in senibus male omnino cedit; quia partes sunt obstinatiores, calor imbecillior. Itaque aut obstinatio partium mollienda, aut calor intendendus; atque de malacissatione membrorum postea dicemus, cum jam ante etiam plura quæ ad duritiem hujusmodi prohibendam et præveniendam pertinent proposuerimus. De calore autem intendendo jam simplici præcepto utemur, si prius etiam alterum axioma assumpserimus.

4. Actus assimilationis (qui a calore, ut diximus, circumfuso excitatur) est motus admodum accuratus et subtilis, et in minimis. Omnes autem hujusmodi motus tum demum sunt in vigore, cum omnis localis motus cesset qui eum obturbet. Etenim motus separationis in homogenea qui in lacte est, ut flos supernatet, serum subsidat, nunquam fiet si lac leniter agitetur: neque putrefactio ulla in aqua aut

mistis procedet, si illa continuo localiter moveantur. Ex his itaque quæ assumpta sunt, hoc jam ad inquisitionem præsentem concludemus.

5. Actus ipse assimilationis perficitur præcipue in somno et quiete, præsertim versus auroram, facta jam distributione: non habemus igitur aliud, quod ad præcipiendum occurrit, nisi ut homines dormiant in calido; atque insuper, ut versus auroram sumatur aliqua inunctio, vel indusium intinctum, excitans moderate calorem, atque post illud sumptum redintegretur somnus. Atque de actu ultimo assimilationis hæc inquisita sunt.

IX.

OPERATIO SUPER INTENERATIONEM EJUS QUOD AREFIERI CŒPIT, SIVE MALACISSATIO CORPORIS.

Connexio.

De inteneratione per interius, quæ per multas ambages et circuitus fit, tam alimentationis quam detentionis spiritus, (ideoque sensim perficitur) superius inquisitum est; de ea autem quæ fit per exterius et quasi subito, sive de corpore malacissando, jam videndum est.

Historia.

1. In fabula de restitutione Peliæ in juventutem, Medea, cum id se moliri fingeret, eam proposuit rationem rei conficiendæ; ut corpus senis in frusta concideretur, deinde in lebete cum medicamentis quibusdam decoqueretur. Coctio fortasse aliqua ad hoc requiretur, concisione in frusta scilicet non est opus.

2. Attamen etiam concisio in frusta adhibenda aliquatenus videtur, non ferro, sed judicio: cum enim viscerum et partium sit consistentia multum diversa, necesse est ut inteneratio ipsorum non iisdem modis absolvatur, sed ut instituatur cura singulorum, præter ea quæ pertinent ad intenerationem totius massæ corporis; de qua tamen primum.

3. Huic operationi per balnea, unctiones, et similia (si modo sit ejus rei aliqua potestas) satisfieri verisimile est; circa quæ observanda sunt ea quæ sequuntur.

4. Non nimis indulgendum est spei quod hæc res confici posset, propter ea quæ fieri cernimus in imbibitionibus et macerationibus inanimatorum, per quas illa intenerantur; cujus aliqua exempla superius adduximus; facilior enim est operatio hujusmodi super inanimata, quia attrahunt et sugunt liquores: at in corpore animali difficilior, quia motus in iis fertur potius ad circumferentiam.

5. Ideo balnea, quæ in usu sunt, emollientia parum prosunt, sed obsunt potius; quia extrahunt magis, quam imprimunt; et solvunt compagem corporis, potius quam consolidant.

6. Balnea et unctiones, quæ operationi præsenti (corporis scilicet bene et solide malacissandi) inservire possint, tres debent habere proprietates.

7. Prima et præcipua est, ut constent ex iis quæ tota substantia similia sunt corpori et carni humanis, quæque sint tanquam alma et nutricantia per exterius.

8. Secunda est, ut habeant admista ea quæ subtilitate nonnulla imprimant, ut vim nutritivam eorum quibus admiscentur insinuent et inculcent.

9. Tertia, ut recipiant nonnullam mixturam (licet reliquis longe minorem) eorum quæ sunt astringentia; non austera aut acerba, sed unctuosa et confortantia; ut dum reliqua duo operentur, interim prohibeatur (quantum fieri potest) exhalatio e corpore, quæ virtutem malacissantium perdat; sed potius ut per astrictionem cutis et clausuram meatuum, motus ad intra promoveatur et juvetur.

10. Consubstantiale maxime corpori humano est sanguis tepidus, vel ex homine vel ex aliis animalibus: at Ficini illud commentum, ad instaurationem virium in senibus, de exuctione sanguinis humani ex brachio adolescentis sani[1], leve admodum est: etenim quod per interius nutrit nullo modo debet esse æquale aut plane homogeneum corpori quod nutritur; sed aliquatenus inferius et subordinatum, ut subigi possit: at in exterius applicatis, quanto substantia est similior, tanto consensus melior.

11. Ab antiquo receptum est, balneum ex sanguine infantium sanare lepram, et carnes jam corruptas restituere[2]; adeo ut hoc ipsum fuerit regibus quibusdam invidiæ apud plebem.

[1] De Vit. Prod. ii. 11.

[2] See Nicephor. vii. 33., and Pliny, xxvi. 5.

12. Proditum est Heraclitum, hydrope laborantem, se in ventre calido bovis nuper occisi immersisse.[1]

13. In usu est sanguis tepidus catulorum felis, ad erysipelata et instaurandas carnes et cutem.

14. Brachium aut membrum aliquod abscissum, aut ex quo sanguis alias nimium profluit, utiliter inseritur in ventrem alicujus animalis nuper dissectum; nam potenter operatur ad sistendum sanguinem; sanguine membri abscissi sanguinem recentem animalis per consensum sorbente et ad se vehementer trahente; unde et ipse sistitur et refluit.

15. Multum in usu est in morbis extremis et quasi desperatis, ut columbæ scissæ, aliæ post alias mutatæ, ad plantas pedum ægroti apponantur; unde sequitur interdum auxilium mirabile; id vulgo imputatur, quasi maligna morbi traherent; sed utcunque caput petit ista medicatio, et spiritus animales confortat.

16. Verum balnea ista et unctiones sanguinolentæ nobis videntur sordidæ et odiosæ; videndum de aliis, quæ minus fortasse habent fastidii, neque tamen minus juvamenti.

17. Post sanguinem igitur recentem, similia substantiæ corporis humani sunt alimentosa, carnes pinguiores, bovinæ, suillæ, cervinæ; ostrea inter pisces; lac, butyrum; vitella ovorum; pollen tritici; vinum dulce, aut saccharatum, aut mulsum.

18. Quæ admisceri debent ad impressionem, sunt, loco omnium, sales, præsertim niger; etiam vinum (cum spiritu turgeat) imprimit et utile est vehiculum.

19. Astringentia ejus generis quæ descripsimus, unctuosa scilicet et confortantia, sunt crocus, mastix, et myrrha, et baccæ myrti.

20. Ex his, pro nostro judicio, optime fiet balneum quale desideramus. Medici et posteri meliora reperient.

21. Longe autem potentior fiet operatio, si balneum quale proposuimus (quod caput rei esse arbitramur) comitetur quadruplex operationis series sive ordo.

22. Primo, ut balneum præcedat fricatio corporis, et inunctio ex oleo, cum aliquo spissamento; ut virtus et calor humectans balnei potius subintret corpus, quam aquea pars liquoris. Deinde, sequatur balneum ipsum, ad horas forte duas. A balneo autem emplastretur corpus ex mastice,

[1] There is no authority for this; it is only said that he covered himself with cowdung. Diog. Laert. ix. 4., and Ménage's notes.

myrrha, tragacantho, diapalma, croco, ut cohibeatur (quantum fieri potest) perspiratio, donec malacum paulatim vertatur in solidum; idque per viginti quatuor horas, vel amplius. Postremo, amota emplastratione, fiat unctio cum oleo, addito sale et croco; et renovetur balneum post quatriduum, cum emplastratione et unctione (ut prius), et continuetur hujusmodi malacissatio per mensem unum.

23. Etiam durante tempore malacissationis utile judicamus, et proprium, et secundum intentionem nostram, ut corpus bene nutriatur, et ab aëre frigido abstineatur, et nil nisi calidum bibatur.

24. Hoc vero (ut initio in genere monuimus) est ex iis quæ nobis experimento probata non sunt, sed descripta tantummodo ex collimatione ad finem. Etenim meta posita, aliis lampada tradimus.

25. Neque negligenda sunt fomenta ex corporibus vivis. Ficinus ait (neque id per jocum) Davidem contubernio puellæ, alias salubriter, sed nimis sero usum fuisse[1]; debuerat autem addere, quod puellam illam, more virginum Persiæ, oportuisset inungi myrrha et similibus; non ad delicias, sed ad augendam virtutem fomenti ex corpore vivo.

26. Barbarossa, ætate extrema, ex consilio medici Judæi puerulos continue stomacho et iliis applicabat ad fomenta[2]: etiam senes nonnulli caniculas (animalia scilicet inter calidissima) stomacho noctu applicare consueverunt.

27. De hominibus quibusdam nasonibus (qui, irrisionis pertæsi, nasorum tuberes et quasi surculos amputarunt, atque in brachiorum ulnas, incisione nonnulla adapertas, ad tempus insuerunt, atque inde nasos magis decentes efformarunt) increbuit relatio quasi certa, idque in multis nominibus: ea si vera sit, consensum carnis ad carnem, præsertim vivarum, plane testatur.

28. De inteneratione particulari viscerum principalium, stomachi, pulmonum, jecoris, cordis, cerebri, spinalis medullæ, renum, fellis, iliorum, venarum, arteriarum, nervorum, cartilaginum, ossium, nimis longa foret inquisitio et præscriptio; cum jam non praxim instruamus, sed indicationes ad praxim.

[1] De Vitâ producendâ, ii. 8. There is a mystical chapter in Roger Bacon's tract, *De retardand. Senect. Accidentibus*, which his translator Browne conceives to relate to this mode of supporting animal heat.

[2] Paul. Jovius, Elog. vi. in Hariodenus.

X.

OPERATIO SUPER EXPURGATIONEM SUCCI VETERIS ET RESTITUTIONEM SUCCI NOVI, SIVE RENOVATIONEM PER VICES.

Historia.

Licet quæ hic ponemus superius fere præoccupata sint, tamen quia ista operatio est ex principalibus, retractabimus ea paulo fusius.

1. Certum est, boves aratores atque laboribus exhaustos, in pascua nova et læta admissos, carnes recipere teneras et juveniles; idque esu et palato comprobari; ut manifestum sit carnium intenerationem non esse difficilem: verum et carnis intenerationem sæpius repetitam etiam ad ossa et membranas et similia pervenire posse verisimile est.

2. Certum est, diætas quæ in usu sunt, ex guaiaco præcipue, atque ex sarsa-perilla, et china[1], et sassafras, præsertim longius continuatas et secundum regulas rigidiores, universum corporis succum primo attenuare, deinde consumere atque sorbere; quod manifestissimum est quia morbum Gallicum usque ad gummositates provectum, quique intimos corporis succos occupaverit et depravaverit, ex illis diætis posse curari probatum est: atque insuper quia æque manifestum est per hujusmodi diætas homines factos macilentos, pallidos, et quasi cadaverosos, paulo post impinguari, colorari, et manifesto renovari. Quamobrem hujusmodi diætas, vergente ætate, semel biennio, ad intentionem nostram utiles esse omnino existimamus, tanquam exuvias et spolia serpentum.

3. Fidenter dicimus (neque vero quis, rogo, nos inter Hæreticos Catharos reponat) purgationes repetitas, atque factas familiares, longe magis ad diuturnitatem vitæ facere, quam exercitia et sudores.[2] Id autem fieri necesse est, si teneatur quod positum est; unctiones corporis, et meatuum ab extra oppletiones, et aëris exclusiones, et spiritus in massa corporis detentiones, plurimum conducere ad vitam longævam. Etenim certissimum est, per sudores et perspirationes exteriores, non

[1] See Gerard's Herbal, 1617.

[2] Bacon again alludes to certain of the charges made against the Manichæans. Dr. Friend remarks that this recommendation of purgatives as a means of prolonging life had already been made by Roger Bacon.

solum humores et vapores excrementitios exhalari et absumi; sed una etiam succos et spiritus bonos, qui non tam facile reparantur: in purgationibus autem (nisi fuerint admodum immoderatæ) non item, cum super humores præcipue operentur. Purgationes autem ad hanc intentionem optimæ sunt, quæ paulo ante cibum sumuntur, quia desiccant minus; ideoque debent esse ex iis catharticis, quæ ventriculum minime turbant.

Intentiones operationum quas proposuimus (ut arbitramur) verissimæ sunt; remedia intentionibus fida. Neque credibile est dictu (licet haud pauca ex ipsis velut plebeia videri possint) quanta cum cura et delectu ea a nobis examinata fuerint; ut sint (salva semper intentione) et tuta et efficacia. Rem ipsam experimentum et comprobabit et promovebit. Talia autem in omnibus rebus sunt opera consilii cujusque prudentioris; quæ sunt effectu admiranda, ordine quoque egregia, modis faciendi tanquam vulgaria.

ATRIOLA MORTIS.

Ad Art 15. *Connexio.* De atriolis mortis jam inquirendum; id est, de iis quæ accidant morientibus in articulo mortis, et paulo ante, et post: ut cum multis viis perveniatur ad mortem, intelligi possit in quæ communia illæ desinant; præcipue in mortibus quæ inferuntur per indigentiam naturæ, potius quam per violentiam; tametsi etiam aliquid ex his propter rerum connexionem inspergendum sit.

Historia.

1. Spiritus vivus videtur tribus indigere, ut subsistat: motu commodo; refrigerio temperato; et alimento idoneo. Flamma vero duobus ex his tantum indigere videtur; motu nimirum et alimento; propterea quod flamma simplex sit substantia, spiritus composita; ita ut si transeat paulo propius in naturam flammeam, se perdat.

2. Etiam flamma majore flamma et potentiore resolvitur et necatur, ut bene notavit Aristoteles[1]; multo magis spiritus.

3. Flamma, si comprimatur nimium, extinguitur; ut cernere

[1] Problems, iii. 22. and xxxiii. 2.

est in candela, superimposito vitro: etenim aër per calorem dilatatus contrudit flammam, eamque minuit et extinguit; neque in caminis concipitur flamma, si materies, absque spatio aliquo interjecto, compingatur.

4. Etiam ignita compressione extinguuntur; veluti si carbonem ignitum ferro aut pede fortiter comprimas, extinguitur statim ignis.

5. At ut ad spiritum veniamus; si sanguis aut phlegma irruat in ventriculos cerebri, fit mors subito; cum spiritus non habeat ubi se moveat.

6. Contusio etiam capitis vehemens inducit subitam mortem, spiritibus in ventriculis cerebri angustiatis.

7. Opium et alia narcotica fortiora coagulant spiritum, eumque privant motu.

8. Vapor venenatus, spiritui totaliter odiosus, infert mortem subitam, ut in venenis mortiferis, quæ operantur per malignitatem (ut loquuntur) specificam; incutit enim fastidium spiritui, ut amplius movere aut rei tam inimicæ occurrere nolit.

9. Etiam extrema ebrietas, aut crapula, quandoque inferunt mortem subitam; cum spiritus non tam densitate aut malignitate vaporis (ut in opio et venenis malignis), quam ipsa copia, obruatur.

10. Extremus mœror et metus, præsertim subitus (ut fit in nuncio malo et improviso), quandoque dant subitam mortem.

11. At non solum nimia compressio, sed etiam nimia dilatatio spiritus, mortifera.

12. Gaudia ingentia et repentina complures exanimarunt.

13. In magnis evacuationibus, quales fiunt in secandis hydropicis, exeuntibus confertim aquis; multo magis in ingentibus et repentinis profluviis sanguinis, sequitur sæpius mors subita; idque per meram *fugam vacui* in corpore, omnibus affatim moventibus ad spatia implenda quæ exinaniuntur, atque inter alia spiritu ipso: nam quoad profluvia sanguinis tardiora, res spectat ad indigentiam alimenti, non ad refusionem spiritus. Atque de motu spiritus, in tantum vel compresso vel effuso ut mortem inferat, hæc inquisita sunt.

14. Veniendum ad indigentiam refrigerii.[1] Cohibitio respirationis mortem infert subitam, ut in omni suffocatione aut

[1] The theory of Aristotle touching respiration was, that it was necessary in order to keep the animal heat from becoming excessive. See his *De Respirat.*

strangulatione. Neque tamen videtur res referri debere tam ad impedimentum motus, quam ad impedimentum refrigerii; quia aër nimis calidus, licet libere attractus, non minus suffocat, quam si inhibeatur respiratio; ut fit in iis, qui suffocati aliquando sunt ex carbonibus incensis, aut lithanthracibus, aut parietibus recenter dealbatis, in cubiculis clausis, igne etiam accenso: quod genus mortis traditur fuisse imperatoris Joviniani. Aut etiam ex balneis siccis super-calefactis, quod usurpatum fuit in nece Faustæ, Constantini magni uxoris.[1]

15. Valde pusillum est tempus, quo natura anhelitum repetit, atque expelli fuliginem aëris in pulmones attracti, et recentem intro-recipi desiderat; vix certe ad tertiam partem minutæ.

16. Rursus pulsus arteriarum et motus cordis, systoles et diastoles, triplo velocior quam respiratio; adeo ut si fieri posset ut ille motus in corde absque inhibita respiratione sisti posset, sequeretur mors etiam celerius quam ex strangulatione.

17. Usus tamen et consuetudo in hac naturali actione respirationis nonnihil valet; ut in urinatoribus Deliis et piscatoribus perlarum, qui perpetuo usu decuplum temporis ad minimum retinere anhelitum possunt, plusquam pro ratione aliorum hominum.

18. Sunt ex animalibus, etiam ex iis quæ pulmones habent, alia quæ ad longius tempus, alia quæ ad brevius, anhelitum cohibere possunt; prout majore scilicet aut minore indigent refrigerio.

19. Pisces minore indigent refrigerio quam animalia terrestria: indigent tamen, atque refrigerantur per branchias: atque quemadmodum terrestria aërem nimis fervidum aut occlusum non ferunt, ita et pisces in aqua glacie totaliter et diutius cooperta suffocantur.

20. Si spiritus insultum patiatur ab alio calore, proprio longe vehementiore, dissipatur et perditur. Si enim proprium calorem non sustineat absque refrigerio, multo minus alienum intensiorem tolerare potest; id cernitur in febribus ardentibus, ubi calor humorum putrefactorum calorem nativum superat, usque ad extinctionem sive dissipationem.

21. Somni quoque indigentia et usus refertur ad refrigerium. Motus enim spiritum attenuat et rarefacit, et calorem ejus acuit et intendit. Somnus contra motum et discursum ejus sedat et

[1] Zosimus, ii. p. 10.

compescit. Etsi enim somnus actiones partium et spirituum mortualium, et omnem motum ad circumferentiam corporis roboret et promoveat; tamen motum proprium spiritus vivi magna ex parte consopit et tranquillat. At somnus regulariter semel infra 24 horas naturæ humanæ debetur, idque ad sex aut quinque horas ad minimum; licet sint etiam in hac parte quandoque naturæ miracula; ut refertur de Mæcenate[1], quod longo tempore ante obitum non dormisset. Atque de indigentia refrigerii ad spiritum conservandum, hæc inquisita sint.

22. Quod vero ad tertiam indigentiam attinet (alimenti scilicet) videtur illa ad partes potius quam ad spiritum vivum pertinere. Facile enim quis credat, spiritum vivum subsistere in identitate, non per successionem aut renovationem. Atque quoad animam rationalem in homine, certo certius est, eam nec ex traduce[2] esse, nec reparari, nec interire. Loquuntur de spiritu naturali animalium, atque etiam vegetabilium, qui ab illa altera essentialiter et formaliter differt; ex horum enim confusione metempsychosis illa, et innumera tam ethnicorum quam hæreticorum commenta emanarunt.

23. Renovatio per alimentum in corpore humano regulariter singulis diebus requiritur. Triduanum autem jejunium sanis vix toleratur: usus tamen et consuetudo, etiam in hac parte, haud parum valet: at morbo languentibus inedia minus gravis est. Etiam somnus alimentationi nonnihil parat, quemadmodum contra exercitatio eam efflagitat magis. Inventi etiam sunt (sed raro) aliqui, qui, quodam naturæ miraculo, sine cibo et potu ad tempus non mediocre vixerunt.

24. Corpora mortua, si non intercipiantur a putredine, diutius sine notabili absumptione subsistunt: at corpora viva non multum ultra triduum (ut dictum est) nisi reparentur per alimentationem; id quod indicat citam illam absumptionem esse opus spiritus vivi, qui aut se reparat, aut partes ponit in necessitate se reparandi, aut utrunque: quam rem etiam illud adstruit (quod paulo ante notatum est), nempe, quod possint animalia sine alimento paulo diutius durare, si dormiant. At somnus omnino nil aliud est, quam receptio spiritus vivi in se.

25. Copiosa nimis et continua effluxio sanguinis, qualis ali-

[1] Pliny, vii. 52.

[2] "Hæreticum est dicere quod anima intellectiva traducatur cum semine" — *S. Thomas, Sum. Theol.* i. 118. 2.

quando fit ab hæmorrhoidibus, interdum a vomitu sanguineo, venis interioribus reseratis aut fractis, interdum ex vulneribus, mortem infert festinam: cum sanguis venarum sanguini arteriarum ministret; sanguis arteriarum, spiritui.

26. Haud parvum est quantum cibi et potus, quod homo bis in die pastus intra corpus recipit: longe plus, quam aut per sellam aut per urinam aut per sudores egerit: nil mirum (inquis), cum reliquum in succos et substantiam corporis mutetur. Recte: sed cogita paulisper, quod ea accessio fit bis in die, neque tamen corpus exundat; similiter, licet spiritus reparetur, tamen quanto suo non enormiter excrescit.[1]

27. Nil attinet adesse alimentum in gradu remoto, sed ejus generis et ita præparatum et ministratum, ut spiritus in illud agere possit. Neque enim baculus cerei sufficiet ad flammam continuandam, nisi adsit cera; neque homines herbis solis pasci possunt: atque inde fit atrophia senilis, quod licet adsit caro et sanguis, tamen spiritus est factus tam paucus et rarus, et succi et sanguis tam effœti et obstinati, ut non teneat proportio ad alimentandum.

28. Subducamus calculos indigentiæ, secundum cursum naturæ ordinarium et consuetum. Explicatione motus sui in ventriculis cerebri et nervis, indiget spiritus perpetuo: motu cordis, tertia parte momenti; respiratione, singulis momentis; somno et alimento, intra triduum; potentia ad alimentandum, quasi post octoginta annos. Atque si aliqui ex his indigentiis non succurratur, sequitur mors. Atque tria plane esse videntur atriola mortis: destitutio spiritus, in motu suo; in refrigerio; in alimento.

Monita. 1. Erraverit, qui existimet spiritum vivum, exemplo flammæ, perpetuo generari et extingui, nec ad tempus aliquod notabile durare. Neque enim hoc facit flamma ipsa ex natura sua, sed quia inter inimica versatur: nam flamma intra flammam durat. At spiritus vivus inter amica degit et obsequia plurima. Itaque cum flamma sit substantia momentanea, aër autem substantia fixa, spiritus vivi media est ratio.

2. De interitu spiritus per destructionem organorum (qualis fit per morbos et violentiam) non est inquisitio præsens (ut ab initio diximus); tametsi et ille in eadem

[1] The explanation is of course to be found in the phenomena of respiration. The suggestion of the difficulty is in itself remarkable.

tria atriola desinat. Atque de ipsa forma mortis hæc inquisita sint.

29. Duo sunt magni præcursores mortis; alter a capite, alter a corde missus: convulsio et extremus labor pulsus; nam etiam singultus ille lethalis est convulsionis genus; labor autem pulsus lethalis habet velocitatem insignem, quandoquidem cor sub ipsa morte ita trepidet, ut systole et diastole fere confundantur; habet etiam conjunctam debilitatem et humilitatem, et sæpius intermissionem magnam, labascente motu cordis, nec fortiter aut constanter insurgere valente.

30. Præcedunt etiam mortem in propinquo summa inquietudo et jactatio; motus manuum floccos colligendo; nixus prehensionis et tentionis fortis; dentes etiam fortiter comprimere; glutire vocem; tremor labii inferioris; pallor oris; memoria confusa; sermonis privatio; sudores frigidi; corporis elongatio; sublatio albuginis oculorum; faciei totius alteratio (naso acuto, oculis concavis, genis labantibus); linguæ contractio et convolutio; frigus extremitatum; in aliquibus emissio sanguinis aut spermatis; clamor acutus; anhelitus creber; inferioris maxillæ lapsus, et similia.[1]

31. Mortem sequuntur sensus omnis et motus, tam cordis et arteriarum quam nervorum et artuum, privatio; impotentia corporis se sustentandi erectum; rigor nervorum et partium; depositio omnis caloris; paulo post putrefactio et fœtor.

32. Anguillæ, serpentes, et insecta diu moventur singulis partibus post concisionem; ut etiam rustici putent partes singulas ad se rursus uniendum expedire. Etiam aves capitibus avulsis ad tempus subsultant: quin et corda animalium avulsa diu palpitant. Equidem meminimus ipsi vidisse hominis cor, qui evisceratus erat (supplicii genere apud nos versus proditores recepto), quod in ignem de more injectum saltabat in altum, primo ad sesquipedem, et deinde gradatim ad minus; durante spatio (ut meminimus) septem aut octo minutarum. Etiam vetus et fide digna traditio est, de bove sub eviscerationem mugiente. At magis certa de homine, qui eo supplicii genere (quod diximus) evisceratus, postquam cor avulsum penitus esset, et in carnificis manu, tria aut quatuor verba

[1] This is taken from the *Prænotiones* of Hippocrates, whose description of the appearance of a person in articulo mortis has given rise to the phrase "facies Hippocratica."

precum auditus est proferre; quod idcirco magis credibile esse diximus quam illud de sacrificio, quia solent amici hujusmodi reorum mercedem dare carnifici, ut officium suum pernicissime expediat, quo illi celerius a doloribus liberentur; in sacrificiis vero non videmus causam cur similis præstetur a sacerdote diligentia.

33. Ad resuscitandum eos qui deliquia animi aut catalepses subitas patiuntur (quorum haud pauci, absque ope, etiam expiraturi fuissent), hæc sunt in usu. Exhibitio aquarum ex vino distillatarum (quas aquas vocamus calidas et cordiales); inflexio corporis in pronum; obturatio fortis oris et narium; flexio digitorum cum tortura quadam; evulsio pilorum barbæ aut capitis; frictio partium, præsertim faciei et extremorum; subita inspersio aquæ frigidæ in faciem; strepitus acuti et subiti; appositio ad nares aquæ rosaceæ, cum aceto, in languoribus; incensio plumarum, pannorum, in suffocatione uteri: at maxime sartago fervefacta utilis est apoplecticis; etiam fotus arctus corporum vivorum aliquibus profuit.

34. Complura fuerunt exempla hominum tanquam mortuorum; aut expositorum e lecto, aut delatorum ad funus, quinetiam nonnullorum in terra conditorum; qui nihilominus revixerunt; id quod in iis qui conditi sunt, repertum est (terra aliquanto post aperta) per obtusionem et vulnerationem capitis ex jactatione et nixu cadaveris intra feretrum: cujus exemplum recentissimum et maxime memorabile fuit Joannis Scoti, subtilis illius et scholastici; qui a servo, cum sepultus esset absente, (quique, ut videtur, hujusmodi catalepsium ejus symptomata noverat) aliquanto post effossus, in tali statu repertus est [1]: et simile quiddam accidit nostra ætate, in persona histrionis sepulti Cantabrigiæ. Memini me accepisse de generoso quodam, qui ludibundus ex curiositate desiderabat scire qualia paterentur in patibulo suspensi, seseque suspendit, super scabellum se allevans et deinde se demittens, putans etiam penes se futurum ut scabellum pro arbitrio suo recuperaret; id quod facere non potuit, sed tamen ab amico præsente adjutus est: ille interrogatus, quid passus esset? retulit se dolorem non sensisse; sed primo obversatam sibi fuisse circa oculos speciem ignis et incendii; deinde extremæ

[1] This story is examined, and as it seems sufficiently refuted, by Wadding in his life of Duns Scotus (1644) p. 50. et seq. It was not the custom of the Franciscans to bury in coffins at all.

nigredinis, sive tenebrarum; postremo coloris cujusdam cœrulei pallidioris, sive thalassini; qualis etiam conspicitur sæpe animo linquentibus. Audivi etiam de medico adhuc vivente, qui hominem qui se suspenderat, atque per horam dimidiam suspensus manserat, in vitam fricationibus et balneis calidis reduxerat; quique etiam profiteri soleat, se non dubitare, quin suspensum quemcunque ad tempus prædictum revocare posset, modo cervices ei per impetum primæ demissionis non fuerint effractæ.

DISCRIMINA JUVENTUTIS ET SENECTUTIS.

Ad Art. 16. 1. Scala humani corporis talis est: concipi; vivificari in utero; nasci; mamilla; depulsio a mamilla; usus cibi et potus ab initio, qualis infantibus convenit; dentire primo, circa annum secundum; incipere gradiri; incipere loqui; dentire secundo, circa annum septimum; pubescere, circa annum duodecimum aut decimum quartum; potentem esse ad generandum, et fluxus menstruorum; pili circa tibias et axillas; barbescere; atque huc usque, et quandoque ulterius, grandescere; deinde roboris artuum status et ultimitas, etiam agilitatis; canescere et calvescere; cessatio menstrui et potentiæ generationis; vergere ad decrepitum, et animal tripes; mori. Interim animus quoque suas habet periodos, sed per annos non possunt describi: ut memoriam labilem, et similia, de quibus postea.

2. Discrimina juventutis et senectutis hæc sunt. Cutis juveni lævis et explicata; seni arida et rugosa, præsertim circa frontem et oculos: carnes juveni teneræ et molles; seni duriores: robur juveni et agilitas; seni diminutio virium et motuum tarditas: juveni coctionum validitas; seni debilitas; juveni viscera mollia et succulenta; seni salsa et retorrida: juveni corpus erectius; seni inclinatio in curvum: juveni constantia artuum; seni debilitas et tremor: juveni humores biliosi, et sanguis fervidior; seni humores phlegmatici et melancholici, et sanguis frigidior: juveni venus in promptu; seni tardior: juveni succi corporis magis roscidi; seni magis crudi et aquei: juveni spiritus multus et turgescens; seni paucus et jejunus: juveni spiritus densus et viridis; seni acris et rarus; juveni sensus vivaces et integri; seni hebetiores et deficientes: juveni dentes robusti et integri; seni debiles, attriti et decidui:

juveni pili colorati; seni, cujuscunque fuerint coloris, cani: juveni coma; seni calvities: juveni pulsus grandior et incitatior; seni obscurior et tardior: juveni morbi magis acuti et curabiles; seni magis chronici, et curatu difficiles: juveni vulnera citius coalescentia; seni tardius: juveni genæ florentes calore; seni aut pallidæ aut rubicundæ, atque sanguine spisso; juveni minor molestia ex catarrhis; seni major: neque scimus in quæ proficiant senes (quoad corpus) nisi quandoque in obesitatem; cujus causa præsto est, quia corpora senum nec bene perspirant, nec bene assimilant: pinguedo autem nihil aliud est, quam exuberantia alimenti ultra id quod excernitur aut perfecte assimilatur. Etiam in quibusdam senibus in edacitatem proficitur, propter acidos humores, licet senes digerant minus. Ac universa quæ jam diximus, medici, quasi feriantes, referent ad caloris naturalis et humoris radicalis diminutionem, quæ res nihili sunt ad usum. Illud certum, siccitatem in de cursu ætatis frigiditatem præcedere; atque corpora cum sint in statu et acme caloris, ad siccitatem declinare; frigiditatem autem postea sequi.

3. Jam vero etiam de affectibus animi videndum. Equidem memini, cum adolescens essem Pictavii in Gallia, me consuevisse familiariter cum Gallo quodam, juvene ingeniosissimo, sed paululum loquaci, qui postea in virum eminentissimum evasit; ille in mores senum invehere solitus est, atque dicere, si daretur conspici animos senum, quemadmodum cernuntur corpora, non minores appariturus in iisdem deformitates: quinetiam ingenio suo indulgens, contendebat vitia animorum in senibus vitiis corporum esse quodammodo consentientia et parallela. Pro ariditate cutis, substituebat impudentiam; pro duritie viscerum, immisericordiam; pro lippitudine oculorum, oculum malum et invidiam; pro immersione oculorum et curvatione corporis versus terram, atheismum (neque enim cœlum, inquit, respiciunt, ut prius); pro tremore membrorum, vacillationem decretorum, et fluxam inconstantiam; pro inflexione digitorum, tanquam ad prehensionem, rapacitatem et avaritiam; pro labascentia genuum, timiditatem; pro rugis, calliditatem et obliquitatem: et alia quæ non occurrunt. Sed ut serii simus: juveni

[1] It would probably be impossible to determine to whom reference is here made Bacon's acquaintance was probably a student in the university of Poitiers, which comprised all the four faculties, but seems notwithstanding never to have enjoyed any high reputation. It was founded in 1431 by Charles VII.

adest pudor et verecundia; seni paululum obduruit: juveni benignitas et misericordia; seni occalluit: juveni æmulatio laudabilis; seni invidia maligna: juveni inclinatio ad religionem et devotionem, ob fervorem et inexperientiam mali; seni defervescentia in pietate, ob charitatis teporem, et diutinam conversationem inter mala, necnon ob credendi difficultatem: juveni valde velle; seni moderatio: juveni levitas quædam et mobilitas; seni gravitas major et constantia: juveni liberalitas, et beneficentia, et philanthropia; seni avaritia, et sibi sapere et consulere: juveni confidentia, et bene sperare; seni diffidentia, et plurima habere pro suspectis: juveni facilitas et obsequium; seni morositas et fastidium: juveni sinceritas et animus apertus; seni cautio et animus tectus: juveni magna appetere; seni necessaria curare: juveni præsentibus rebus favere; seni antacta potiora habere: juveni superiores revereri; seni censura in illos uti: et complura alia, quæ ad mores potius pertinent quam ad inquisitionem præsentem. Attamen, quemadmodum in corpore, ita in animo, in nonnulla proficiunt senes, nisi fuerint admodum emeriti; nempe, ut cum ad excogitandum minus sint prompti, judicio tamen valeant, et tutiora et saniora quam speciosiora malint; etiam in garrulitatem proficiunt et ostentationem; fructum enim sermonis petunt, cum rebus minus valeant; ut non absurde Tithonum in cicadam versum fuisse poëtæ fingant.

CANONES MOBILES

DE DURATIONE VITÆ, ET FORMA MORTIS.

Canon I.

Non fit consumptio, nisi quod deperditum sit de corpore transmigret in corpus aliud.

EXPLICATIO.

Nullus est rerum interitus: itaque quod absumitur, aut evolat in aërem aut recipitur in corpus aliquod adjacens: quare videmus araneam aut muscam aut formicam, in electro, monumento plus quam regio, sepultas, æternizari; cum tamen sint res teneræ et dissipabiles. Verum non adest aër, in quem aliquid evolet; atque substantia electri est tam heterogenea, ut nihil ex illis recipiat. Simile etiam fore arbitramur, misso ligno aut radice, aut ejusmodi, in argentum vivum. At cera

et mel et gummi habent similem operationem sed ex parte tantum.

Canon II.

Inest omni tangibili spiritus, corpore crassiore obtectus et obsessus; atque ex eo originem habet consumptio et dissolutio.

EXPLICATIO.

Nullum corpus nobis notum, hic in superiore parte terræ, spiritu vacat; sive per attenuationem et concoctionem caloris cœlestium, sive alias. Neque enim cava rerum tangibilium vacuum recipiunt; sed aut aërem, aut spiritum rei proprium. Spiritus autem ille (de quo loquimur) non est virtus aliqua, aut energia, aut entelechia, aut nugæ: sed plane corpus tenue, invisibile; attamen locatum, dimensum, reale: neque rursus spiritus ille aër est (quemadmodum nec succus uvæ est aqua); sed corpus tenue, cognatum aëri, at multum ab eo diversum: partes autem rei crassiores (cum sint naturæ pigræ, nec admodum mobilis) per periodos longas duraturæ forent, sed spiritus ille est qui turbat et illas fodicat et subruit, atque humidum corporis et quicquid digerere potest in novum spiritum deprædatur; deinde tam spiritus corporis præinexistens, quam noviter factus, simul sensim evolant. Id optime ostenditur in diminutione ponderis corporum arefactorum per perspirationem. Neque enim quicquid emittitur erat spiritus, quando ponderaverat; neque non spiritus, quando evolaverat.

Canon III.

Spiritus emissus desiccat; detentus et moliens intus, aut colliquat, aut putrefacit, aut vivificat.

EXPLICATIO.

Quatuor sunt processus spiritus: ad arefactionem; ad colliquationem; ad putrefactionem; ad generationem corporum. Arefactio non est opus proprium spiritus, sed partium crassiorum, post emissum spiritum: tum enim illæ se contrahunt, partim per fugam vacui, partim per unionem homogeneorum; ut liquet in omnibus quæ arefiunt per ætatem, et in siccioribus corporibus quæ desiccantur per ignem, ut lateribus, carbonibus, panibus. Colliquatio est merum opus spirituum, neque fit nisi calore excitentur; tum enim spiritus se dilatantes, neque tamen exeuntes, se insinuant et perfundunt inter partes crassiores,

easque ipsas reddunt molles et fusiles; ut in metallis et cera: etenim metalla, et alia tenacia, apta sunt ad cohibendum spiritum, ne excitatus evolet. Putrefactio est opus mixtum spiritus et partium crassiorum: etenim spiritu (qui partes rei continebat et frænabat) partim emisso, partim languescente, omnia solvuntur et redeunt in heterogeneas suas, sive (si placet) elementa sua; quod spiritus inerat rei, congregatur ad se (unde putrefacta incipiunt esse gravis odoris); oleosa ad se (unde putrefacta habent nonnihil lævoris et unctuositatis); aquea itidem ad se; fæces ad se (unde fit confusio illa in putrefactis). At generatio, sive vivificatio, est opus itidem mixtum spiritus et partium crassiorum, sed longe alio modo; spiritus enim totaliter detinetur, sed tumet et movetur localiter; partes autem crassiores non solvuntur, sed sequuntur motum spiritus, atque ab eo quasi difflantur et extruduntur in varias figuras; unde fit illa generatio et organizatio: itaque semper fit vivificatio in materia tenaci et lenta, atque etiam sequaci et molli; ut simul et spiritus fiat detentio, atque etiam cessio lenis partium, prout eas effingit spiritus: atque hoc cernitur in materia omnium tam vegetabilium quam animalium, sive generentur ex putrefactione, sive ex spermate; in his enim omnibus manifestissime cernitur esse materia difficilis ad abrumpendum, facilis ad cedendum.

Canon IV.

In omnibus animatis duo sunt genera spirituum: spiritus mortuales, quales insunt inanimatis; et superadditus spiritus vitalis.

EXPLICATIO.

Jam ante dictum est, ad longævitatem procurandam, debere considerari corpus humanum, primo, ut inanimatum et inalimentatum; secundo, ut animatum et alimentatum; nam prior consideratio dat leges de consumptione, secunda de reparatione. Itaque nosse debemus, inesse humanis carnibus, ossibus, membranis, organis, denique partibus singulis, dum vivunt, in substantia earum perfusos, tales spiritus quales insunt in hujusmodi rebus, carne, osse, membrana, et cæteris, separatis et mortuis; quales etiam manent in cadavere: at spiritus vitalis, tametsi eos regat, et quendam habeat cum illis consensum, longe alius est ab ipsis; integralis et per se constans. Sunt autem duo discrimina præcipua inter spiritus mortuales et spiritus vitales; alterum,

quod spiritus mortuales minime sibi continuentur, sed sint tanquam abscissi et circundati corpore crassiore, quod eos intercipit; quemadmodum aër permixtus est in nive aut spuma. At spiritus vitalis omnis sibi continuatur, per quosdam canales, per quos permeat, nec totaliter intercipitur. Atque hic spiritus etiam duplex est; alter ramosus tantum, permeans per parvos ductus et tanquam lineas; alter habet etiam cellam, ut non tantum sibi continuetur, sed etiam congregetur in spatio aliquo cavo, in bene magna quantitate, pro analogia corporis; atque in illa cella est fons rivulorum, qui inde diducantur. Ea cella præcipue est in ventriculis cerebri, qui in animalibus magis ignobilibus angusti sunt; adeo ut videantur spiritus per universum corpus fusi, potius quam cellulati: ut cernere est in serpentibus, anguillis, muscis, quorum singulæ portiones abscissæ moventur diu: etiam aves diutius capitibus avulsis subsultant; quoniam parva habeant capita, et parvas cellas; at animalia nobiliora ventriculos eos habent ampliores; et maxime omnium homo. Alterum discrimen inter spiritus est; quod spiritus vitalis nonnullam habeat incensionem, atque sit tanquam aura composita ex flamma et aëre; quemadmodum succi animalium habeant et oleum et aquam. At illa incensio peculiares præbet motus et facultates; etenim et fumus inflammabilis, etiam ante flammam conceptam, calidus est, tenuis, mobilis; et tamen alia res est, postquam facta sit flamma; at incensio spirituum vitalium multis partibus lenior est quam mollissima flamma, ex spiritu vini, aut alias; atque insuper mixta est, ex magna parte, cum substantia aërea; ut sit et flammeæ et aëreæ naturæ mysterium.

Canon v.

Actiones naturales sunt propriæ partium singularum, sed spiritus vitalis eas excitat et acuit.

EXPLICATIO.

Actiones sive functiones quæ sunt in singulis membris naturam ipsorum membrorum sequuntur (attractio, retentio, digestio, assimilatio, separatio, excretio, perspiratio, etiam sensus ipse); pro proprietate organorum singulorum (stomachi, jecoris, cordis, splenis, fellis, cerebri, oculi, auris, et cæterorum). Neque tamen ulla ex ipsis actionibus unquam actuata foret, nisi ex vigore et præsentia spiritus vitalis et caloris ejus; quemadmodum nec ferrum aliud ferrum attracturum foret, nisi excita-

retur a magnete; neque ovum unquam fœcundum foret, nisi substantia fœmellæ actuata fuisset ab initu maris.

Canon vi.

Spiritus mortuales aëri proxime consubstantiales sunt; spiritus vitales magis accedunt ad substantiam flammæ.

EXPLICATIO.

Explicatio canonis quarti præcedentis est etiam declaratio canonis præsentis; verum insuper hinc fit, ut quæcunque sint pinguia et oleosa diu maneant in esse suo; neque enim aër illa multum vellicat; neque illa etiam ipsa cum aëre conjungi multum desiderant: illud autem prorsus vanum est, quod flamma sit aër accensus, cum flamma et aër non minus heterogenea sint quam oleum et aqua. Quod vero dicitur in canone, quod spiritus vitales magis accedant ad substantiam flammæ; illud intelligendum est, quod magis hoc faciant quam spiritus mortuales; non quod magis sint flammei quam aërei.

Canon vii.

Spiritus desideria duo sunt; unum se multiplicandi; alterum exeundi, et se congregandi cum suis connaturalibus.

EXPLICATIO.

Intelligitur canon de spiritibus mortualibus; etenim quoad desiderium secundum, spiritus vitalis exitum e corpore suo maxime exhorret; neque enim invenit connaturalia hic in proximo: ruit forte in occursum rei desiderabilis, ad extima corporis sui; sed egressum, ut dictum est, fugit: verum de spiritibus mortualibus utrunque desiderium tenet; quod ad[1] primum enim attinet, omnis spiritus, inter crassiora locatus, non fœliciter habitat; itaque cum simile sui non inveniat, eo magis simile sui creat et facit, in tali solitudine positus; et strenue laborat, ut se multiplicet et volatile crassiorum deprædetur, ut augeatur suo quanto. Quod vero ad secundum desiderium evolandi et se in aërem recipiendi; certum est omnia tenuia (quæ semper sunt mobilia) ad sui similia in proximo libenter ferri; ut bulla aquæ fertur ad bullam, flamma ad flammam: at multo magis hoc fit in evolatione spiritus in aërem ambientem; quia non fertur ad particulam sui similem, sed etiam tanquam

[1] *Quuad* in the original: corrected in Rawley's edition, 1638.—*J. S.*

ad globum connaturalium suorum. At illud interim notandum; quod exitus et evolatio spiritus in aërem est duplicata actio; partim ex appetitu spiritus, partim ex appetitu aëris; aër enim communis tanquam res indigens est, atque omnia avide arripit; spiritus, odores, radios, sonos, et alia.

Canon VIII.

Spiritus detentus, si alium spiritum gignendi copiam non habeat, etiam crassiora intenerat.

EXPLICATIO.

Generatio novi spiritus non fit nisi super ea quæ sunt in gradu ad spiritum propiore; qualia sunt humida. Itaque si partes crassiores (inter quas versatur spiritus) sint in gradu remotiore, licet spiritus eas conficere non possit, tamen (quod potest) eas labefactat, et emollit, et fundit; ut cum quantum suum augere non possit, tamen habitet laxius, et inter ea degat quæ sint magis amica: iste autem aphorismus ad finem nostrum admodum utilis est; quia innuit ad intenerationem partium obstinatarum per detentionem spiritus.

Canon IX.

Inteneratio partium duriorum bene procedit, cum spiritus nec evolet nec generet.

EXPLICATIO.

Iste canon solvit nodum et difficultatem in operatione intenerandi per detentionem spiritus: si enim spiritus non emissus deprædatur omnia intus, nil fit lucri ad intenerationem partium in esse suo; sed potius solvuntur illæ et corrumpuntur. Itaque una cum detentione refrigerari debent spiritus et astringi, ne sint nimis activi.

Canon X.

Calor spiritus ad viriditatem corporis debet esse robustus, non acris.

EXPLICATIO.

Etiam iste canon pertinet ad solvendum nodum supradictum, sed longe latius patet; describit enim qualis debeat esse temperamenti calor in corpore ad longævitatem. Hoc vero utile est, sive spiritus detineantur, sive non; utcunque enim talis debet esse calor spirituum, ut vertat se potius in dura, quam deprædetur mollia: alterum enim desiccat, alterum intenerat. Quinetiam, eadem res valet ad alimentationem bene perficiendam;

talis enim calor optime excitat facultatem assimilandi, atque una optime præparat materiam ad assimilandum. Proprietates autem hujusmodi caloris tales esse debent: primo ut tardus sit nec subito calefaciat; secundo, ut non sit admodum intensus, sed mediocris; tertio, ut sit æqualis, non incompositus, scilicet se intendens et remittens; quarto, ut, si inveniat calor iste quod ei resistat, non facile suffocetur aut langueat. Subtilis admodum hæc operatio; sed cum sit ex utilissimis, non deserenda est. Nos vero in remediis (quæ ad indendum spiritibus calorem robustum, sive eum quem vocamus fabrilem, non prædatorium, proposuimus) huic rei aliqua ex parte satisfecimus.

Canon xi.

Spirituum densatio in substantia sua valet ad longævitatem.

explicatio.

Subordinatus est canon ad præcedentem; etenim spiritus densior suscipit omnes illas quatuor caloris proprietates, quas diximus. Modi autem densationis in prima ex decem operationibus habentur.

Canon xii.

Spiritus in magna copia et magis festinat ad exitum et magis deprædatur, quam in exigua.

explicatio.

Clarus est per se canon iste, cum quantum ipsum regulariter augeat virtutem; atque cernere est in flammis, quod quanto fuerint majores, tanto et erumpant fortius et absumant celerius. Itaque nimia copia aut turgescentia spiritus prorsus nocet longævitati: neque amplior est optanda copia spirituum, quam quæ muniis vitæ et bonæ reparationis ministerio sufficiat.

Canon xiii.

Spiritus æqualiter perfusus minus festinat ad exitum et minus deprædatur, quam impariter locatus.

explicatio.

Non solum copia spirituum secundum totum durationi rerum obest; sed etiam eadem copia, minus refracta, similiter obest. Itaque quo magis fuerit spiritus comminutus, et per minima

insinuatus, eo deprædatur minus. Dissolutio enim incipit a parte ubi spiritus est laxior; itaque et exercitatio et fricationes longævitati multum conferunt: agitatio enim optime comminuit et commiscet res per minima.

Canon xiv.

Motus spirituum inordinatus et subsultorius magis properat ad exitum et magis deprædatur, quam constans et æqualis.

EXPLICATIO.

In inanimatis tenet iste canon certo; inæqualitas enim dissolutionis mater; in animatis vero (quia non solum spectatur consumptio, sed reparatio; reparatio autem procedit per rerum appetitus: appetitus rursus acuitur per varietatem) non tenet rigide; sed eousque tamen recipiendus est, ut varietas ista potius sit alternatio quam confusio, et tanquam constans in inconstantia.

Canon xv.

Spiritus in corpore compagis solidæ detinetur, licet invitus.

EXPLICATIO.

Omnia solutionem continuitatis suæ exhorrent; attamen pro modo densitatis aut tenuitatis suæ. Etenim, quo corpora sunt magis tenuia, eo in minores et angustiores meatus se compelli patiuntur: itaque aqua subintrabit meatum, quem non subintrabit pulvis; aër etiam, quem non subintrabit aqua; quin flamma et spiritus, quem non subintrabit aër. Veruntamen est hujusce rei aliquis terminus; neque enim spiritus in tantum desiderio exeundi laborat, ut patiatur se discontinuari nimis, et in nimis arctos poros aut meatus agi; itaque si spiritus corpore duro aut etiam unctuoso et tenaci (quod non facile dividitur) circundetur, plane constringitur, et tanquam incarceratur, et appetitum exeundi posthabet; quare videmus metalla et lapides longo ævo egere ut exeat spiritus; nisi aut spiritus igne excitetur, aut partes crassiores aquis corrodentibus et fortibus disjungantur. Similis est ratio tenacium, qualia sunt gummi, nisi quod leniore calore solvantur. Itaque succi corporis duri, cutis constricta, et similia, (quæ procurantur ab alimentorum siccitate, et exercitatione, et aëris frigore) utilia sunt ad longævitatem; quia claustra circundant spiritui arcta, ne exeat.

Canon xvi.

In oleosis et pinguibus detinetur spiritus libenter, licet non sint tenacia.

EXPLICATIO.

Spiritus, si nec a corporis circundati antipathia irritetur, nec a corporis nimia similitudine pascatur, nec a corpore externo solicitetur aut provocetur, non tumultuatur multum ad exeundum: quæ omnia oleosis desunt; nam nec tam spiritui infesta sunt, quam dura; nec tam propinqua, quam aquea; nec cum aëre ambiente bene consentiunt.

Canon xvii.

Evolatio cita humoris aquei conservat diutius oleosum in esse suo.

EXPLICATIO.

Diximus aquea, utpote aëri consubstantialia, citius evolare, oleosa tardius, ut cum aëre minus consentientia: at cum humidum utrunque plerisque corporibus insit, evenit ut aqueum veluti prodat oleosum; nam illud sensim exiens, hoc etiam asportat. Itaque nil magis juvat ad corporum conservationem, quam siccatio lenis, quæ humorem aqueum expirare faciat, nec oleosum solicitet; tum enim oleosum fruitur natura sua: neque hoc spectat ad inhibendam putredinem (licet etiam et illud sequatur) sed ad conservandam viriditatem. Hinc fit, ut fricationes molles et exercitationes moderatæ, ad perspirationem potius quam ad sudorem, longævitati plurimum conferant.

Canon xviii.

Aër exclusus confert ad longævitatem, si aliis incommodis caveas.

EXPLICATIO.

Diximus paulo ante, evolationem spiritus esse actionem duplicatam, ex appetitu spiritus et aëris. Quare si altera tollatur, haud parum proficitur; id quod ex inunctionibus præcipue expectari debet. Attamen hoc sequuntur varia incommoda; quibus quomodo subveniatur, in operatione secunda ex decem annotavimus.

Canon xix.

Spiritus juveniles senili corpori inditi, naturam compendio retrovertere possint.

EXPLICATIO.

Natura spirituum est quasi rota suprema, quæ alias rotas in corpore humano circumagit. Itaque illa in intentione longævitatis prima poni debet. Huc accedit, quod facilior et magis expedita via patet ad alterandos spiritus, quam ad alia. Etenim duplex est operatio super spiritus; altera per alimenta, quæ est tarda, et tanquam per circuitum; altera (et illa gemina) quæ est subita, et spiritus recta petit: nempe per vapores, aut per affectus.

CANON XX.

Succi corporis subduri et roscidi faciunt ad longævitatem.

EXPLICATIO.

Ratio perspicua est, cum antea posuerimus, dura et oleosa, sive roscida, ægrius dissipari. Illud tamen interest (sicut etiam in operatione decima notavimus), quod succus subdurus minus dissipabilis est, sed est simul minus reparabilis. Itaque commodum cum incommodo conjunctum est: neque possit propterea aliquod magnale per hoc præstari; at succus roscidus utrique rei satisfacit; itaque diligentius huic incumbendum.

CANON XXI.

Quicquid tenuitate penetrat, neque tamen acrimonia rodit, gignit succos roscidos.

EXPLICATIO.

Canon iste magis difficilis est practica, quam intellectu; manifestum est enim, quicquid bene penetrat, sed tamen cum stimulo aut dente (qualia sunt omnia acria et acida), relinquere, ubicunque transit, vestigium nonnullum siccitatis et divulsionis; ut succos induret, partes convellat; at contra, quæ penetrant mera tenuitate, tanquam furtim et insinuative, absque violentia, irrorare et irrigare in transitu. De his in operationibus quarta et septima haud pauca descripsimus.

CANON XXII.

Assimilatio optime fit, cessante omni motu locali.

EXPLICATIO.

Hunc canonem in commentatione ad operationem octavam satis explicavimus.

Canon xxiii.

Alimentatio per exterius, aut saltem non per stomachum, longævitati utilissima, si fieri possit.

EXPLICATIO.

Videmus omnia quæ per nutritionem peraguntur, fieri per longas ambages; quæ vero per amplexus similium (ut fit in infusionibus) non longam requirere moram. Itaque utilissima foret alimentatio per exterius; atque èo magis, quod deciduæ sint facultates concoctionum sub senectute: quamobrem si possint esse nutritiones aliæ auxiliares, per balneationes, unctiones, aut etiam per clysteria, conjuncta possint proficere, quæ singula minus valeant.

Canon xxiv.

Ubi concoctio debilis est ad extrusionem alimenti, ibi exteriora confortari debent ad evocationem alimenti.

EXPLICATIO.

Non est hoc, quod in isto canone proponitur, eadem res cum præcedente; aliud enim est, si alimentum exterius intro trahatur, aliud, si alimentum interius extra trahatur: at in hoc concurrunt, quod debilitati concoctionum interiorum alia via subveniant.

Canon xxv.

Omnis subita renovatio corporis fit aut per spiritus aut per malacissationes.

EXPLICATIO.

Duo sunt in corpore, spiritus et partes; ad utrunque longa via pervenitur per nutritionem; at viæ breves ad spiritus per vapores et affectus; et ad partes, per malacissationes. Illud autem paulo attentius notandum, quod nullo modo confundimus alimentationem per exterius cum malacissatione; neque enim intentio est malacissationis, ut nutriat partes; sed tantum ut eas reddat magis idoneas ad nutriendum.

Canon xxvi.

Malacissatio fit per consubstantialia, imprimentia, et occludentia.

EXPLICATIO.

Manifesta ratio est; quod consubstantialia proprie malacis-

sent; imprimentia deducant; occludentia retineant, et perspirationem, quæ est motus malacissationi oppositus, cohibeant. Itaque (ut in operatione nona descripsimus) malacissatio simul bene fieri non potest, sed per seriem et ordinem: primum, excludendo liquorem, per spissamenta; quia extranea et crassa infusio non bene coagmentet corpus; subtile debet esse, et ex vaporis genere, quod intrat. Secundo, intenerando, per consensum consubstantialium: corpora enim ad tactum eorum quæ valde consentiunt, se aperiunt, et poros laxant. Tertio, imprimentia vehicula sunt, et nonnihil consubstantialia inculcant, et mixtura leniter astringentium perspirationem interim paululum cohibet. At sequitur quarto loco magna illa astrictio et clausura per emplastrationem; et postea gradatim per inunctionem; donec malacum vertatur in solidum, ut suo loco diximus.

Canon xxvii.

Crebra renovatio reparabilium irrigat etiam minus reparabilia.

EXPLICATIO.

Diximus in aditu ipso historiæ hujus, eam esse viam mortis, quod magis reparabilia in consortio minus reparabilium intereant; ut totis viribus in reparatione hujusmodi partium minus reparabilium sit exudandum. Itaque admoniti Aristotelis observatione de plantis, quod scilicet *novitas ramorum truncum ipsum in transitu reficiat*, similem rationem fore arbitrati sumus, si sæpe reparentur carnes et sanguis in corpore humano; ut inde ipsa ossa, et membranæ, et reliqua, quæ natura minus sunt reparabilia, partim per transitum alacrem succorum, partim per vestitum illum novum carnium et sanguinis recentiorum, irrigentur et renoventur.

Canon xxviii.

Refrigeratio quæ non transit per stomachum, utilis ad longævitatem.

EXPLICATIO.

Ratio præsto est, quia cum refrigeratio non temperata, sed potens, (præsertim sanguinis) ad vitam longam sit præcipue necessaria; omnino hoc non fieri possit per intus, quantum opus est, absque destructione stomachi et viscerum.

Canon xxix.

Complicatio illa, quod tam consumptio quam reparatio sint caloris opera, maximum est obstaculum ad longævitatem.

EXPLICATIO.

Destruuntur fere omnia magna opera a naturis complicatis; cum quod alia ratione juvet, alia noceat; atque hic librato judicio et sagaci practica opus est; id nos, quantum res permittit et in præsentia occurrit, fecimus; separando calores benignos a nocivis; et ea quæ ad utrunque faciunt.

Canon xxx.

Curatio morborum temporariis eget medicinis; at longævitas vitæ expectanda est a diætis.

EXPLICATIO.

Quæ ex accidente superveniunt, sublatis causis desinunt: at cursus naturæ continuus, instar fluvii labentis, etiam continua indiget remigatione aut velificatione in adversum: itaque operandum est regulariter per diætas. Diætæ autem genere duplices sunt; diætæ statæ, quæ certis temporibus, et diæta familiaris, quæ in victu quotidiano, usurpari debet: potentiores autem sunt diætæ statæ, id est, series remediorum ad tempus; etenim quæ tanta virtute pollent, ut naturam retro vertere valeant, fortiora sunt plerunque, et magis subito alterantia, quam quæ familiariter in usum recipi tuto possint. Atque in remediis nostris intentionalibus, tres tantum diætas statas reperias: diætam opiatam; diætam malacissantem; et diætam emaciantem et renovantem. At inter ea quæ ad diætam familiarem et victum quotidianum præscripta a nobis sunt, efficacissima sunt hæc quæ sequuntur; quæ etiam validitatem diætarum statarum fere æquant: nitrum, et subordinata ad nitrum; regimen affectuum, et studiorum genus; refrigeria quæ non transeunt per stomachum; potus roscidantes; perspersio sanguinis cum materia firmiore, ut margaritis, lignis; inunctiones debitæ, ad cohibendum aërem et detentionem spirituum; calefactoria per exterius, tempore assimilationis post somnum; cautio de iis quæ incendunt spiritum, induntque ei calorem acrem, ut de vinis et aromatibus; et usus moderatus et tempestivus eorum quæ indunt spiritibus calorem

robustum, ut croci, nasturtii, allii, enulæ, opiatorum compositorum.

Canon xxxi.

Spiritus vivus interitum patitur immediate, cum destituitur, aut motu, aut refrigerio, aut alimento.

EXPLICATIO.

Sunt hæc scilicet illa tria, quæ superius vocavimus atriola mortis; suntque passiones spiritus propriæ et immediatæ. Etenim organa omnia partium principalium serviunt, ut hæc tria officia præstentur: et rursus, omnis destructio organorum quæ est lethifera, eo rem deducit ut unum aut plura ex his tribus deficiant. Itaque alia omnia sunt diversæ viæ ad mortem; sed in hæc desinunt. Fabrica autem partium, organum spiritus est; quemadmodum et ille animæ rationalis; quæ incorporea est et divina.

Canon xxxii.

Flamma substantia momentanea est: aër fixa: spiritus vivi in animalibus, media est ratio.

EXPLICATIO.

Res est hæc et altioris indagationis et longioris explicationis, quam faciat ad inquisitionem præsentem. Sciendum interim flammam continenter generari et extingui; ut per successionem tantum continuetur. Aër autem corpus fixum est, nec solvitur: licet enim aër ex humido aqueo novum aërem gignat, tamen vetus aër nihilominus manet; unde fit superoneratio illa aëris, de quo diximus in titulo de Ventis. At spiritus utriusque naturæ particeps est, et flammeæ et aëreæ; quemadmodum et fomites ejus sunt oleum, quod est homogeneum flammæ; et aër, qui est homogeneus aquæ. Spiritus enim non nutritur ex oleoso simplici, neque ex aqueo simplici, sed ex utroque: atque licet nec aër cum flamma, nec oleum cum aqua, bene componantur, tamen satis conveniunt in misto. Etiam spiritus habet ex aëre faciles suas et delicatas impressiones et receptiones; a flamma autem, nobiles suos et potentes motus et activitates. Similiter etiam duratio spiritus res composita est, nec tam momentanea quam flammæ, nec tamen tam

fixa quam aëris; atque eo magis non sequitur rationes flammæ, quod flamma etiam ipsa extinguitur per accidens, nempe a contrariis et destruentibus circumfusis, quam causam et necessitatem non habet pariter spiritus. Reparatur autem spiritus ex sanguine vivido et florido arteriarum exilium, quæ insinuantur in cerebrum; sed fit reparatio ista suo modo, de quo nunc non est sermo.

HISTORIA DENSI ET RARI.

PREFACE

TO THE

HISTORIA DENSI ET RARI.

BY ROBERT LESLIE ELLIS.

THE following treatise, which is one of the five histories mentioned in the *Historia Naturalis*, was published in 1658 by Dr. Rawley. A good deal of its contents occur in an imperfect and fragmentary state in the *Phænomena Universi*.[1]

It has somewhat the appearance of having been left unfinished, and excepting a table of specific gravities and an account of the way in which this table was constructed, contains little that is now of interest. The table occurs also in the *Phænomena Universi:* in the *Historia Densi et Rari* one substance is omitted and six added, so that the whole number of substances mentioned, which is seventy-three in the former, is seventy-eight in the latter work.

This table of specific gravities is the only collection of quantitative experimental results that we find in Bacon's works. Few experiments of the same kind had previously been made. The method which Bacon employed enables us to form some opinion as to the amount of his acquaintance with mathematical physics.

The first table of specific gravities was constructed by Marinus Ghetaldus[2], whose *Archimedes Promotus* was published

[1] One of the fragments published by Gruter in 1651, which will be printed in Part III. of this edition. My own impression is that much of the first portion of the present treatise — from the first *tabula* down to the *monitum*, p. 259. — is of earlier date than Gruter's copy, and less perfect; and that the remainder only — extending from the first *connexio* to the end — is to be regarded as the *Historia Densi et Rari* which Rawley mentions as having been composed by Bacon during his last *quinquennium*; the previous part being made up of notes and loose papers written at various times, many of them long before, and never digested into order. See my note at the end of this preface. — *J. S.*

[2] It appears from Harriot's papers, now in the British Museum, that before the

in 1603. It contains only twelve substances, and is therefore, so far as the number of experiments is concerned, much inferior to Bacon's. But on the other hand Ghetaldus is the author of the method of finding specific gravities which, with certain modifications and corrections, has remained in use to the present day, whereas no one, probably, has attempted to find specific gravities by Bacon's process. The principle of Ghetaldus's method consists in weighing the substance which is to be examined in air and in water, and thus ascertaining the weight of the water which it displaces. By this method the comparison of the densities of different substances is made to depend on the first principles of hydrostatics. The often-told story of Archimedes and Hiero's crown contains the germ of the same method; and it is probably from this that Ghetaldus took the title of his book. It contains however, beside the tables of specific gravities, certain corollaries from propositions in Archimedes's treatise on the equilibrium of floating bodies, enough to show that Ghetaldus was entitled to profess himself a follower of Archimedes.[1] Towards the end of his treatise he tells the story of Archimedes and Hiero, and remarks on the practical defects of the method which Archimedes employed. The chief inaccuracy arises from the effect of capillary attraction on the surface of the water, which makes it difficult to know when the vessel, into which the crown or other substance to be examined is introduced, is only just full. Ghetaldus's remark, that the water which overflows cannot be collected and measured without loss, is no doubt correct; but it does not seem that this way of trying the experiment was employed by Archimedes. After putting the crown into a vessel full of water and thus making a part of the water overflow, he filled the vessel again, measuring the quantity of water poured in. Repeating this experiment with a mass of gold equal in weight to the crown, and then again with a mass of silver also of equal weight, he found that the crown displaced more water than the gold and less than the silver, and thereby showed that the crown was not of pure gold. It does not seem, from what Vitruvius says, that Archimedes calculated the amount

publication of the *Archimedes Promotus*, he knew how to determine specific gravities by weighing in air and water. We are not however entitled to assert, as Baron Zach has done, that his experiments preceded those of Ghetaldi. See the supplement to Dr. Bradley's Miscellaneous Works, by Prof Rigaud, pp. 43 and 51.

[1] "Isti vero opusculo nomen ab Archimede, quem ducem sequor, imposui."

of alloy which it contained. In truth he had not sufficient data for the purpose, unless it was clear that the gold was alloyed only with silver.

After pointing out the defects of Archimedes's method, Ghetaldus remarks that they are effectually avoided by weighing the body in air and water, in the manner which he has already described. In this manner it is not necessary to take masses of equal weight in air, in order to compare the specific gravities; any particle of each is sufficient for the required experiments.

The simplicity and modesty of Ghetaldus's style — he says of himself, "is enim ego sum, qui malim scire quam nosci; discere quam docere:"[1] — make us unwilling to believe that he was aware that the method of weighing in air and water, in order to compare specific gravities, was not new. Yet it had been given in a slightly different form in one of the most popular books of the time,—the *Natural Magic* of Porta. The error however which Porta has made in applying it seems to be good evidence in favour of Ghetaldus, who would scarcely have omitted an opportunity of pointing it out.

Porta, like Ghetaldus, tells the story of Hiero's crown, and after saying something of the practical objections to the method which Archimedes employed, goes on to remark that the method he is about to describe is so much better than the old one, "ut dicere possimus *ὑπερεύρηκα ὑπερεύρηκα*."[2] Take, he says, the metal whose purity is to be examined, and an equal weight of the same metal known to be free from all alloy. Place them in the scales of an accurate balance, and when they are in equilibrium, immerse both scales in water. It will be seen that the impure metal will rise, and that the other will sink. Thus, in the case of gold alloyed with silver, if we would know how much silver it contains, we must put it in the one scale, and in the other as much pure gold as will produce equilibrium under water. Then lift both scales out of the water, and determine the excess of weight which was necessary to produce equilibrium in the water. This excess is the weight of the alloy. Again, if you would

[1] "I had rather know than be known," is one of the sentences in Bacon's *Promus*. — *J. S.*

[2] There is, of course, no such word as *ὑπερευρίσκω*, nor would it mean what Porta wishes to express. But his meaning is obvious.

know how much gold there is in the gilding of a silver vessel: Put the vessel in one scale, and balance it in air with pure silver: put both scales into water; and the weight of the gold which must be added to the pure silver in order to restore the balance is the weight of the gilding. Both these methods are entirely wrong.[1] But Porta goes on, after remarking that they are applicable to other alloys beside that of gold and silver, to give certain statements of the weight of iron and other metals as weighed in air and in water, which constitute in effect a table of specific gravities. For some reason or other, they almost all err in the same direction, making the substances to which they relate appear lighter than they really are. Probably Porta forgot that the scale in which the body was placed, was itself buoyed up by the water. However that may be, he says that an iron ball weighing nineteen ounces in air weighs fifteen in water, which would make the specific gravity of iron only four and three quarters. Similarly a ball of lead of thirty-one ounces in air loses four ounces in water: so that the specific gravity of lead is less than eight. He states similar results for six kinds of gold; the highest specific gravity being seventeen. The error in this case may have been caused by the alloy; which is the more probable, as in the case of silver his result is almost absolutely accurate. Silver weighing a hundred and twenty-five grains in air weighs a hundred and thirteen in water. This gives a specific gravity of 10·41. For the precious metals he probably used greater care in making the experiment. Porta manifestly but half understood what he was doing: still he had got possession of the idea that specific weights were to be compared by weighing in air and water; and this idea once got, any person who had read Archimedes's treatise on floating bodies, might easily have done what Ghetaldus did.

I have thought this digression allowable, as the most recent account of the progress of science in Italy, namely M. Libri's,

[1] If, in the case of the first, ρ and σ are respectively the densities of gold and silver, and v, u, and V the volumes of the gold in the debased metal, of the silver, and of the pure gold respectively; then, as they balance in water,

$$\rho v + \sigma u - (v + u) = (\rho - 1) V:$$

and if the excess of weight in air is w, then

$$\frac{w}{g} = \rho v + \sigma u - \rho V = v + u - V = u - \frac{\sigma - 1}{\rho - 1} u,$$

$$\text{or} \quad w = g \frac{\rho - \sigma}{\rho - 1} u, \text{ instead of } = g \sigma u.$$

And similarly in the second case.

contains nothing on the subject. M. Libri remarks, that it is difficult to enumerate Porta's speculations, and still more so to ascertain how much of them he is entitled to claim as his own. In the present case however he is, I think, entitled to at least the credit due to an ingenious mistake.

Porta's method, like that of Archimedes, requires us to have a mass of pure gold equal in weight to the crown or other portion of alloyed metal which is to be examined. Ghetaldus's, on the contrary, is free from this condition, which would in many cases make the other methods wholly useless. But Bacon's, so far from being an improvement on any of those which had preceded it, is the most unmanageable of all. His experiments must have been carefully made in order to give him the degree of accuracy which he has in most cases attained; for nothing can be more inartificial than the process employed. He formed a hollow prism, of which the height is a little greater than the side of the base—the base being a square, and just equal to a side of a cube of gold weighing one ounce. Any substance to be compared with gold is to be formed into a cube of dimensions equal to the ounce cube of gold, which is ascertained by its just fitting into the prism: the weight of the prism being known both when it is empty, and when it carries a cube of the given substance, that of the latter is also known, and its gravity compared to that of gold is thence determined. Consequently this method requires it to be possible to give a cubical form to the substance to be examined; a condition in many cases wholly impracticable, and which in all cases will give rise to many sources of error. In the original problem of Hiero's crown, for instance, Bacon could not have been permitted to cut a piece out in order to mould it into a cube. His method must have been changed, and he could only have advised the king to have another crown made on the same pattern, and of gold known to be unalloyed, and then to see whether the two crowns were of equal weight. It is tolerably certain that he had formed no distinct notion of the problem proposed to Archimedes,—namely, to compare the specific weights of bodies of given forms; because, after remarking that a table of specific gravities may be usefully employed in determining the composition of alloys, he goes on to say, "Arbitror hoc esse εὕρηκα illud Archimedis; sed utcunque ita res est." As in the *Sylva Sylvarum* he has copied largely from the *Natural Magic*, and

even from the neighbourhood of the passage of which I have been speaking, it may appear odd that he had not learnt from Porta what was the real difficulty which Archimedes had to overcome. The most obvious explanation is, that the *Historia Densi et Rari* was written before he had become acquainted with Porta's work.[1]

The use of making the height of the prism greater than the side of the base was this: when fluids were examined, the prism was filled up to a mark placed inside, at the height of the top of the cube, and the depth of the prism being somewhat greater than this height prevented the fluid from overflowing. In a small prism the surface of the fluid will be perceptibly convex; but this source of error was disregarded, or not observed. But, probably, the most remarkable error which Bacon has committed is chiefly owing to this circumstance. Both in the *Phænomena Universi* and the *Historia Densi et Rari*, the weight of the cube of mercury is stated at nineteen pennyweights and nine grains, that of the cube of gold being, as we know, one ounce. The specific gravity of gold is therefore to that of mercury as twenty to nineteen and three eighths; whereas the real ratio is less than twenty to fourteen and a half. Of this large error, a considerable part is accounted for by the convexity of the surface of the mercury. In the other specific gravities of fluids, which admit of an accurate comparison with modern results, there will be found an error in the same direction, though, as we should expect, of a much smaller amount.

Beside solids and fluids, Bacon also made experiments on substances reduced to powder; not however distinguishing between merely mechanical pulverization, and that which is the result of some chemical process. Thus he compares lead "in corpore" and in ceruss, mercury and corrosive sublimate, &c. It was not however to be expected that he should make this distinction.

With respect to the philosophical inferences which he proposes to deduce from the quantitative theory of Density and Rarity, he seems, as usual, to bear somewhat too hardly on Aristotle. It was a received opinion among the disciples of

[1] His attention seems to have been drawn to the point in question afterwards. See "Certain Experiments made by the Lord Bacon about Weight in Air and Water," Part III. of this edition near the end, and Mr. Ellis's note. — *J. S.*

Aristotle that one measure of earth is transmutable into ten of water, and one of water into ten of air. This opinion was no doubt founded on a passage in which Aristotle arguing against the doctrine of Empedocles, who recognising four elements did not admit that they could be transmuted into one another, remarks that if this be denied, we cannot compare them *κατὰ ποσὸν ἢ ποσόν*, according to quantity as such. If we say that one measure of water becomes ten of air, then we may also assert that one measure of water is in point of quantity equal to ten of air; and conversely, in order that the latter statement may have a definite meaning, we must admit that water may be changed into air, or *vice versâ*. Therefore, Aristotle says, we may well be surprised that any of those who compare the elements according to quantity deny their mutual transmutability. In this *argumentum per incommodum* there are two points worthy of notice: in the first place, the complete absence of any notion that the quantity of matter was to be measured by the weight; and in the second, the recognition of the possibility of definite quantitative comparisons among the elements. So clearly is this fixed in Aristotle's mind, that he uses it to show that the elements must be transmutable. There is however no foundation for Bacon's censure[1], that under the sanction of the doctrine that matter is wholly indifferent to differences of form, the schoolmen in effect maintained that any given portion of water might possibly become any quantity of air. He remarks, that if any one asserts that one measure of water can be transmuted into an equal measure of air, he in reality asserts that something which previously existed can be absolutely annihilated; since, taking for argument's sake the common opinion as to the relation between water and air, the single measure of water might have been made into ten of air; so that in order to arrive at the single measure of air nine must have been annihilated. No one, he says, can be so bewildered with abstract subtleties as to believe that there is as much matter in one measure of air as in ten. Certainly not; and the follower of Aristotle would simply remark, that the phrase "as much matter" is, in his sense of the word matter, a phrase without meaning. For to him matter apart from form has no actual existence; it is not *ens actu*, and therefore does

[1] This censure is implied throughout the *Aditus*. I have expressed his argument rather more fully than he has done himself.

not admit of any determination either in the category of quantity or any other. Whatever may be thought of the value of the Aristotelian antithesis of form and matter, we are not at liberty to charge it with difficulties which only arise when we forget that, in this antithesis, matter does not mean any actually existing thing. We must not replace the merely negative notion of the Aristotelian ὕλη by the positive idea of substance, and then interpret the dictum that matter is indifferently susceptible of all forms, so as to make it mean that the quantity of a given portion of substance can be conceived to vary. That this transition from matter to substance has been often made, may readily be admitted; it is only one instance of the tendency of the mind to replace highly abstract notions by others which are less so,—a tendency which, in the history of philosophy, is as the ὁδὸς εἰς τὸ κάτω of Heraclitus.

In commending those who deny that primitive matter is "quanto plane spoliata, licet ad alias formas æqua," Bacon refers to the Averroists, who ascribed to matter, considered apart from any form, extension in three dimensions — interminate extension, as it was usually expressed. Any attempt to give metes and bounds to this interminate extension would have been in the opinion of Averroes, as well as in that of the other followers of Aristotle, to introduce an εἶδος or form. This doctrine was however regarded by the orthodox schoolmen as little less of a heresy than that which Averroes had promulgated touching the soul of man. Another and a somewhat earlier doctrine ascribed to all matter a form of corporeity, prior to the introduction of any special or particular form. Both these doctrines are of Arab origin, the last-mentioned being that of Avicenna: they seem to spring from the same character of mind, though Avicenna's opinion is strongly condemned by Averroes. It does not seem to have ever been received with much assent, though the phrase "form of corporeity" became long afterwards famous, when Duns Scotus introduced it into his psychological theory.

Bacon is scarcely justified in asserting that Aristotle reduced the whole question of density and rarity to "the frigid distinction of act and power." He said, on the contrary, that density and rarity, instead of being, as at first they seem to be, purely qualitative conceptions, pass into another category than that of quality, when they are more narrowly examined. His

expressions are sufficiently remarkable to be quoted:— *ἔοικε . . ἀλλότρια τὰ τοιαῦτα* (namely the rare and the dense, the smooth and the rough) *εἶναι τῆς περὶ τὸ ποιὸν διαιρέσεως· θέσιν γὰρ μᾶλλόν τινα φαίνεται τῶν μορίων ἑκάτερον δηλοῦν· πυκνὸν μὲν γὰρ τῷ τὰ μόρια σύνεγγυς εἶναι ἀλλήλοις, μανὸν δὲ τῷ διεστάναι ἀπ' ἀλλήλων, καὶ λεῖον μὲν τῷ ἐπ' εὐθείας πως τὰ μόρια κεῖσθαι, τραχὺ δὲ τῷ τὸ μὲν ὑπερέχειν τὸ δὲ ἐλλείπειν.* "The dense and the rare, the smooth and the rough, seem to be foreign from the classification of qualities. For each of them seems rather to denote a mode of disposition of the particles: the dense consists in their being near one another, and the rare in their standing apart; the smooth in their lying somehow in a straight line, and the rough in this — that one particle projects and another comes short."

This explanation is precisely the same as Bacon's; and on the other hand Aristotle would have adopted Bacon's caveat "Neque propterea res deducitur ad atomum, qui præsupponit vacuum et materiam non fluxam (quorum utrunque falsum est), sed ad particulas veras quales inveniuntur."[1]

In this as in some other instances, Bacon speaks of Aristotle with needless disrespect. Yet even now Aristotle has not lost his claim to be accounted "il maestro di coloro che sanno."

One of the applications which Bacon makes of his table of specific gravities is to the common doctrine of the elements, to which he esteems it a fatal objection, that many bodies, as gold for instance, are much heavier than the densest of the elements. The objection would be conclusive if it were more difficult to believe that any mixture of the elements could by condensation become of the same specific gravity as gold, than to believe that it could possess the qualities by which gold is distinguished from other substances.

From comparing the densities of tangible bodies "quæ pondere dotantur," Bacon proceeds to speak of aeriform or pneumatical bodies, whose density cannot be judged of by their weight. In classifying aeriform bodies, he distinguishes, as in the *Historia Vitæ et Mortis*, between the crude spirits which are present in every tangible substance, and the animal spirits which are peculiar to living creatures. The latter are much the rarer, and possess positive levity; which appears in

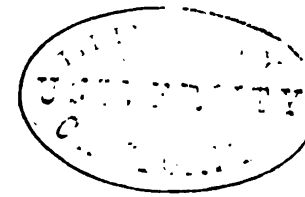
[1] Nov. Org. ii. 6.

the difference of weight of the same animal before and after death. Between these two kinds of spirits stands, in the scale of rarity, the ambient air, which is devoid of levity; a bladder filled with air not being lighter than when empty. It is scarcely necessary to remark that this observation proves nothing. Whether the air was in its own nature light or heavy, a portion of it separated from the rest by being enclosed either in a bladder or in any other envelope would clearly not tend either upwards or downwards. The principle of sufficient reason seems enough to show that any given portion of air must, in relation to the general mass, remain at rest. It is on this account that [J. B. Benedetti], of whom M. Libri gives an account, greatly condemns Aristotle for not having perceived that in its own place air has no weight.[1]

In order to connect the density of tangible bodies with that of air, Bacon tried to ascertain what quantity of spirits of wine would, when converted into vapour, completely fill a bladder of a known size. His result is, that the vapour occupied more than three hundred and twenty times as much space as the spirits themselves.

The remainder of the *Historia Densi et Rari* consists of a miscellaneous collection of remarks on dilatations and condensations, and on the different causes by which these changes are brought about. There is not much of interest in this part of the treatise. The whole concludes, like the *Historia Vitæ et Mortis* and the *Historia Ventorum*, with a number of Canones Mobiles, followed, as in the *Historia Ventorum*, by a list of things yet to be accomplished. The most remarkable circumstance connected with the Canones is the emphatic rejection of the doctrine of a vacuum. In this respect the *Historia Densi et Rari* is completely in accordance with the *Novum Organum*, and both show that Bacon's opinions must have undergone a decided change after the time of his writing the *Cogitationes de Rerum Naturâ*, or the essay on the fable of Cupid.

[1] Libri, Histoire des Sciences Mathém. liv. ii. p. 125.



NOTE.

Dr. Rawley, whose copy of this treatise, as printed in the *Opuscula*, is our only authority for the text, does not tell us in what state he found the manuscript. I apprehend however that it came into his hands either unfinished or mutilated.

It was evidently meant to correspond in form with the two preceding *tituli*, namely the *Historia Ventorum* and the *Historia Vitæ et Mortis*, and to be set forth according to the plan described in the *Norma historiæ præsentis*, p. 17.; and had Bacon prepared it for the press himself, he would certainly not have omitted the *Topica Particularia sive articuli inquisitionis*. This, being a particular description of the order of inquiry, would have followed the *aditus*. Each section of the *historia* would have been assigned by a marginal reference to its proper article, would have been introduced by a *connexio*, and followed by *observationes majores* or *commentationes*; the *monita* and *mandata* being inserted in their places immediately after the paragraphs to which they had reference, and distinguished from the *historia* by italics or some other typographical difference.

Now in Dr. Rawley's edition we find no *Topica Particularia*; consequently no references to the several *articuli inquisitionis* to which the successive portions of the *historia* relate. In the earlier part of the inquiry, which treats *de exporrectione materiæ in corporibus, secundum consistentias suas diversas, dum quiescunt*, we find no *connexiones*, nor anything to indicate the particular relation which the several *tabulæ, monita, mandata, observationes, commentationes*, &c., bear to each other, or to the subject of inquiry. These are all printed in separate groups; each group having its separate heading (*monita, mandata*, &c., as the case may be); and the paragraphs into which they are divided are separately numbered; except towards the end, where the numbers are omitted. Thus the various *monita* which are dispersed through this part of the work are numbered from 1 to 6, after which occur three single ones without any numbers; the various *observationes* from 1 to 9, and afterwards one without any number; the *mandata* from 1 to 4; and so on. The paragraphs however to which the several series of numbers apply are not kept together, but intermingled. After the first *tabula*, for instance, we have *monita* 1, 2, 3, 4; then *observationes*

1, 2, 3; then *mandata* 1, 2; then *observationes* 4, 5, 6; then *mandatum* 3; then *vellicationes de practicâ*, 1, 2, 3, 4; then *observatio* 7; then *historia* 1; and so on. From all which I am inclined to suspect that the arrangement of this part had not been completed by Bacon; that Rawley found the *monita*, *mandata*, &c., set down in numbered paragraphs on separate sheets, and that the distribution of them into their places in the order of inquiry was his own work; a work which, without the help of the *articuli inquisitionis*, which should have given the directions, it would not have been easy to accomplish successfully, even if the materials had been themselves complete, which I can hardly think they were.

However that may be, the result is certainly not satisfactory. As the text stands, the relation which the several paragraphs bear to each other is far from clear, and the typographical arrangement (which differs materially from that adopted by Bacon in the two histories edited by himself) is perplexing from the absence of all distinction between the major and minor divisions; not always consistent with itself; and in some places positively incorrect. That it has not been reproduced in its original form by any subsequent editor, is not therefore a matter of regret; but the changes which have been introduced by modern editors (following, with some variations, the example of Blackbourne) do not appear to me to be exactly of the right kind; the object which they had in view being apparently to make the printed page neater and more compact, rather than to exhibit more clearly the order of inquiry and the divisions of subject.

My own object in arranging the text of this third *titulus*, has been to bring the typographical form more into symmetry with that of the two others. In them, it will be observed, the whole inquiry is distributed into several *articuli;* each article having its separate *connexio*, which marks and explains the transition from the article preceding; its separate *historia*, with *monita*, *mandata*, &c., interspersed; and its separate *observationes* or *commentationes* (as the case may be), generally coming in at the end, and always distinguished (as stepping beyond the region of pure history into that of *interpretation*) by being printed in a larger type. That a similar logical arrangement was meant to be followed in the present history is evident enough even from the text as edited by Rawley. But in order to make this arrangement apparent to the eye, so far as that could be attempted without altering the words or the order of paragraphs, I have found it necessary to introduce some headings which are not in the original, and to alter the places of others. I have not however added anything except within brackets, nor altered or omitted anything without mentioning it in the notes. — *J. S.*

HISTORIA DENSI ET RARI,

[SIVE

TITULUS TERTIUS

IN HISTORIA NATURALI ET EXPERIMENTALI

AD CONDENDAM PHILOSOPHIAM:

QUÆ EST INSTAURATIONIS MAGNÆ PARS TERTIA.][1]

[1] The words within brackets are not in the title as printed by Rawley. But had Bacon himself brought out the work in the same form with the *Historia Vitæ et Mortis*, they would no doubt have been added.— *J. S.*

HISTORIA DENSI ET RARI;

NECNON

COITIONIS ET EXPANSIONIS MATERIÆ PER SPATIA.

ADITUS.

Nil mirum, si natura philosophiæ et scientiis debitrix sit, cum ad reddendas rationes nunquam adhuc sit interpellata. Neque enim de *quanto materiæ*, et *quomodo* illud per corpora sit distributum (in aliis copiose, in aliis parce), instituta est inquisitio diligens et dispensatoria, secundum veros aut proximos veris calculos. Illud recte receptum est, Nil deperdi aut addi summæ universali: etiam tractatus est a nonnullis ille locus, Quomodo corpora laxàri possint et contrahi, absque vacuo intermisto, secundum plus et minus. Densi autem et Rari naturas alius ad copiam et paucitatem materiæ retulit; alius hoc ipsum elusit; plerique, authorem suum secuti, rem totam per frigidam illam distinctionem actus et potentiæ discutiunt et componunt. Etiam qui illa materiæ rationibus attribuunt (quæ vera est sententia), neque materiam primam Quanto plane spoliatam, licet ad alias formas æquam, volunt, tamen in hoc ipso inquisitionem terminant, ulterius nihil quærunt, neque quid inde sequatur perspiciunt; remque, quæ ad infinita spectat, et naturalis philosophiæ veluti basis est, aut non attingunt, aut non urgent.

Primo igitur, quod bene positum est, non movendum: Non scilicet fieri in aliqua transmutatione corporum transactionem aut a nihilo, aut ad nihilum; sed opera esse ejusdem omnipotentiæ, creare ex nihilo, et redigere in nihilum; ex cursu naturæ vero hoc nunquam fieri. Itaque summa materiæ totalis semper constat; nil additur, nil minuitur. At istam summam inter corpora per portiones dividi, nemini dubium esse possit. Neque enim quisquam subtilitatibus abstractis tam dementatus esse queat,

ut existimet tantum materiæ inesse dolio aquæ, quantum decem doliis aquæ; neque similiter dolio aëris, quantum decem doliis aëris. At in corpore eodem non dubitatur quin copia materiæ multiplicetur pro mensura corporis: in corporibus diversis ambigitur. Quod si demonstretur, unum dolium aquæ in aërem versum, decem dare dolia aëris (istam enim computationem propter opinionem receptam sumimus, licet centupla verior sit), bene habet: etenim jam non amplius sunt diversa corpora, aqua et aër, sed idem corpus aëris in decem doliis. At unum dolium aëris (ut modo concessum est) decima tantum pars est decem doliorum. Itaque resisti jam non potest, quin in uno dolio aquæ decuplo plus sit materiæ, quam in uno dolio aëris. Itaque, si quis asserat dolium aquæ totum in dolium aëris unicum verti posse, idem prorsus est ac si asserat aliquid posse redigi ad nihilum. Etenim una decima aquæ ad hoc sufficiet, reliquæ novem partes necesse est ut annihilentur. Contra, si quis asserat dolium aëris in dolium aquæ verti posse, idem est ac si asserat aliquid posse creari ex nihilo. Etenim dolium aëris, nisi[1] ad decimam partem dolii aquæ attinget, reliquæ novem partes necesse est ut fiant ex nihilo. Illud interim plane confitemur, de rationibus et calculis et quota parte quanti materiæ quæ diversis corporibus subest, et qua industria et sagacitate de illis informatio vera capi possit, arduam inquisitionem esse; quam tamen ingens et latissime fusa utilitas compenset. Nam et densitates et raritates corporum nosse, et multo magis condensationes et rarefactiones procurare et efficere, maxime interest et contemplativæ et practicæ. Cum igitur sit res (si qua alia) plane fundamentalis et catholica, accincti debemus ad eam accedere; quandoquidem omnis philosophia absque ea penitus discincta et dissoluta sit.[2]

[1] So in the original. Qu. *non* nisi; and omit the comma?—*J. S.*

[2] Here, if the work had been completed, would no doubt have followed the *Topica Particularia, sive Articuli Inquisitionis de Denso et Raro*, and the order of the subsequent inquiry would have been particularly explained. The *Tabula* which follows is the commencement of the *Historia*.—*J. S.*

[*Historia.*]

TABULA COITIONIS ET EXPANSIONIS MATERIÆ PER SPATIA IN TANGIBILIBUS (QUÆ SCILICET DOTANTUR PONDERE)[1] CUM SUPPUTATIONE RATIONUM IN CORPORIBUS DIVERSIS.

Idem spatium occupant, sive æque exporriguntur,

	Den.	Gr.
Auri puri uncia una, sive	20	0
Argenti vivi	19	9
Plumbi	12	1½
Argenti puri	10	21
Plumbi cinericei; anglice Tynglas	10	12
Cupri	9	8
Aurichalci	9	5
Chalybis	8	10
Æris communis	8	9
Ferri	8	6
Stanni	7	22
Magnetis	5	12
Lapidis Lydii	3	1
Marmoris	2	22¾
Silicis	2	22½
Vitri	2	20½
Crystalli	2	18
Alabastri	2	12
Salis gemmæ	2	10
Luti communis	2	8½
Luti albi	2	5½
Nitri	2	5
Ossis bovis	2	5
Pulveris margaritarum	2	2
Sulphuris	2	2
Terræ communis	2	1½
Vitrioli albi	1	22
Eboris	1	21½
Aluminis	1	21
Olei vitrioli	1	21
Arenæ albæ	1	20
Cretæ	1	18½
Olei sulphuris	1	18
Pulveris salis communis	1	10
Ligni vitæ	1	10

	Den.	Gr.	
Carnis ovillæ	1	10	
Aquæ fortis	1	7	
Cornu bovis	1	6	
Balsami Indi	1	6	
Cerebri vitulini crudi	1	5	paul. min.
Sanguinis ovilli	1	5	
Ligni santali rubei	1	5	
Gagatis	1	5	
Cepæ recentis	1	5	
Lactis vaccini	1	4½	
Caphuræ	1	4	
Succi menthæ expressi	1	4	
Succi boraginis expressi	1	3½	
Cervisiæ lupulatæ fortis	1	3½	
Ligni ebeni	1	3½	
Pulveris seminis fœniculi dulcis	1	3½	
Aceti	1	3½	
Agrestæ, ex pomis acerbis	1	3	
Succini lucidi	1	3	
Urinæ	1	3	
Aquæ communis	1	3	paul. min.
Olei caryophyllorum chymici	1	3	paul. min.
Vini clareti	1	2¾	
Pulveris sacchari albi	1	2½	
Ceræ flavæ	1	2	

[1] In the heading of the corresponding title in the *Phænomena Universi*, the clause "quæ scilicet dotantur pondere" does not occur.

	Den.	Gr.		Den.	Gr.
Radicis Chinæ . . .	1	2	Olei maceris viridis expressi	0	23½
Carnis pyri brumalis crudi	1	2	Pulveris herbæ sampsuci .	0	23
Aceti distillati . . .	1	1	Petrolei	0	23
Aquæ rosaceæ distillatæ .	1	1	Pulveris florum rosæ . .	0	22
Cineris communis . .	1	0½	Spiritus vini . . .	0	22
Myrrhæ	1	0	Ligni quercus . . .	0	19½
Benjovin . . .	1	0	Pulveris fuliginis communis e camino	0	17
Butyri	1	0			
Adipis	1	0			
Olei amygdalini dulcis .	0	23½	Ligni abietis . . .	0	15[1]

Modus experimenti circa tabulam supra-scriptam.

Intelligantur pondera, quibus usi sumus, ejus generis et computationis quibus aurifabri utuntur; ut libra capiat uncias 12, uncia 20 denarios, denarius grana 24. Delegimus autem corpus auri puri, ad cujus exporrectionis mensuram reliquorum corporum rationes applicaremus, non tantum quia gravissimum, sed quia maxime unum et sui simile, nihil habens ex volatili. Experimentum fuit tale: unciam auri puri in figuram aleæ sive cubi efformavimus; dein situlam parvam, quadratam, ex argento paravimus, quæ cubum illum auri caperet, atque ei exacte conveniret; nisi quod situla esset nonnihil altior; ita tamen ut locus intra situlam, quo cubus ille auri ascenderat, linea conspicua signaretur. Id fecimus liquorum et pulverum gratia; ut cum liquor aliquis intra eandem situlam immittendus esset, non diffluerat, sed paulo interius se contineret. Simul autem aliam situlam fieri fecimus, quæ cum altera illa, pondere et contento, prorsus par esset; ut in pari situla corporis contenti tantum ratio appareret. Tum cubos ejusdem magnitudinis sive dimensi fieri fecimus, in omnibus materiis in Tabula specificatis quæ sectionem pati possent; liquoribus vero ex tempore usi sumus, implendo scilicet situlam, quousque liquor ad locum illum linea signatum ascenderet. Pulveribus eodem modo. Sed intelligantur pulveres maxime et fortiter compressi. Hoc enim potissimum ad æquationem pertinet, nec casum recipit. Itaque non alia fuit probatio, quam ut una ex situlis vacua in una lance, altera cum corpore in altera lance poneretur; et ratio

[1] Seventy-eight substances are mentioned in this table, and only seventy-three in that in the *Phænomena*, which contains only one not contained here, namely, "radix caricæ recens." The six which it omits are cerebrum vitulinum crudum, sanguis ovilis, lac vaccinum, succus menthæ expressus, succus boraginis expressus, and cervisia lupulata fortis.

ponderis corporis contenti per se exciperetur. Quanto vero pondus corporis pondere auri est minus, tanto exporrectio corporis est exporrectione auri major. Exempli gratia, cum auri ille cubus det unciam unam, myrrhæ vero denarium unum; liquet, exporrectionem myrrhæ ad exporrectionem auri habere rationem vicecuplam: ut vicies plus materiæ sit in auro quam in myrrha, in simili spatio; rursus, vicies plus exporrectionis sit in myrrha quam in auro, in simili pondere.

Monita. 1. Parvitas vasis quo usi sumus et forma etiam (licet ad cubos illos recipiendos habilis et apta), ad rationes exquisitas verificandas minus propria fuit. Nam nec minutias infra grani quadrantem facile excipere licebat; nec quadrata illa superficies, in parvo nec sensibili ascensu sive altitudine, notabilem ponderis differentiam trahere potuit: contra quam fit in vasis in acutum surgentibus.

2. Minime dubium est, etiam complura corpora, quæ in Tabula ponuntur, intra suam speciem magis et minus recipere, quoad pondera et spatia; nam et vina, et ligna ejusdem speciei, et nonnulla e reliquis, sunt certe alia aliis graviora. Itaque quoad calculationem exquisitam, casum quendam ista res recipit; neque ea individua in quæ experimentum nostrum incidit, naturam speciei exacte referre, neque cum aliorum experimentis fortasse omnino in minimis consentire possunt.

3. In Tabulam superiorem conjecimus ea corpora, quæ spatium sive mensuram commode implere, corpore integro et tanquam similari, possent; quæque etiam pondus habeant; ex cujus rationibus de materiæ coacervatione judicium fecimus. Itaque tria genera corporum huc retrahi non poterant: primo, ea quæ dimensioni cubicæ satisfacere non poterant; ut folia, flores, pelliculæ, membranæ: secundo, corpora inæqualiter cava et porosa, ut spongia, suber, vellera: tertio, pneumatica, quia pondere non dotantur; ut aër, flamma.

4. Videndum, num forte contractio corporis arctior ex vi unita nanciscatur majorem rationem ponderis, quam pro quantitate materiæ. Id, utrum fiat necne, ex Historia propria Ponderis inquiratur. Quod si fiat, fallit certe supputatio: et quo corpora sunt tenuiora, eo paulo plus habent materiæ in simili exporrectione, quam pro calculo ponderis et mensuræ quæ ex eo pendet.

Hanc Tabulam multis abhinc annis confeci, atque (ut memini) bona usus diligentia.[1] Verum possit proculdubio Tabula multo exactior componi; videlicet, tum ex pluribus, tum ampliore quapiam mensura; id quod ad exactas rationes plurimum facit; et omnino paranda est, cum res sit ex fundamentalibus.

Observationes.

1. Licet, atque adeo juvat, animo prospicere, quam finita et comprehensibilis sit natura rerum in tangibilibus. Tabula enim naturam claudit tanquam in pugno. Nemo itaque expatietur, nemo fingat aut somniet. Non invenitur in Tabula ens, quod aliud ens in copia materiæ superet, ultra proportionem tricesimam duplam: tanto enim superat aurum lignum abietis. De interioribus autem terræ nihil decernimus; cum nec sensui nec experimento subjiciantur. Illa, cum a calore cœlestium primo longius, deinde penitus, semota sint, possint esse corporibus nobis notis densiora.

2. Opinio de compositione sublunarium ex quatuor elementis non bene cedit. Aurum enim in situla illa tabulari est ponderis Den. 20; terra communis Den. 2, paulo plus; aqua Den. 1, Gran. 3;[2] aër, ignes, longe tenuiora et minus materiata; ponderis vero nullius. At forma materiam non auget. Videndum igitur, quomodo ex corpore 2 Den. et corporibus longe tenuioribus, educatur per formam, in pari dimenso, corpus 20 Den. Duo sunt effugia: unum, quod elementa tenuiora compingant densiorem in majorem densitatem quam simplicis elementi; alterum, quod non intelligant Peripatetici hoc de terra communi, sed de terra elementari, omni ente composito graviore. At ignis et aër non condensant, nisi per accidens, ut suo loco dicetur. Terra autem illa, quæ foret auro et omnibus gravior, ita sita est, ut vix adsit ad mistionem. Melius igitur foret, ut plane nugari desinant, et cesset dictatura.

3. Diligenter notanda est series sive scala coacervationis materiæ; et quomodo ascendat a coacervatione majore ad

[1] Probably at the time when he wrote the *Phænomena Universi*. If so, the present *tabula*, with the *mandata* belonging to it, must be presumed to be the later copy. — *J. S.*

[2] 33 in the original. — *J. S.*

minorem : idque interdum per gradus, interdum per saltum. Siquidem utilis est hæc contemplatio, et ad judicium et ad practicam. Coagmentatio metallica et subterranea maxima est ; ita ut ex 32 illis partibus occupet 12 : tantum enim distat aurum a stanno. In illo descensu ab auro et argento vivo magnus saltus ad plumbum. A plumbo ad stannum gradatio. Rursus magnus saltus a metallis ad lapides : nisi quod se interponat magnes, qui inde convincitur esse lapis metallicus. A lapidibus vero ad reliqua usque ad levissimum, continui et pusilli gradus.

Mandata. 1. Cum fons densitatis videatur esse in profundo terræ, adeo ut versus superficiem ejus corpora eximie extenuentur ; illud notatu dignum est, quod aurum (quod est ex metallis gravissimum) nihilominus reperiatur quandoque in arenulis et ramentis fluviorum ; etiam fere purum. Itaque inquirendum diligenter de situ ejusmodi locorum : utrum non sint ad pedes montium, quorum fundi et radices æquiparari possint mineris profundissimis, et aurum inde eluatur ; aut quid tandem sit, quod pariat tantam condensationem versus summitates terræ.

2. De mineris in genere quærendum, quæ ex iis soleant esse depressiores, et quæ propius ad superficiem terræ ; et in quali situ regionum, et in qua gleba nascantur ; et quomodo se habeant ad aquas ; et maxime, in quibus cubilibus decumbant et jaceant ; et quomodo circundentur aut misceantur lapide, aut aliquo alio fossili : denique omnes circumstantiæ examinandæ, ut per istas explorari possit, qua ratione succi et spiritus terræ in condensationem istam metallicam (quæ reliquas longe superat) coëant aut compingantur.

Observationes.

4. Dubium minime est, quin et in vegetabilibus, atque etiam in partibus animalium, se ostendant corpora complura ligno abietis longe leviora. Nam et lanugines nonnullarum plantarum, alæ muscarum, et spolia serpentum ; atque artificialia quoque diversa, ut lineus pannus extinctus (quali utimur ad fomites flammarum), et folia rosarum quæ supersunt a distillatione, et hujusmodi, superant levitate (ut putamus) ligna levissima

5. Cohibenda et corrigenda est illa cogitatio, in quam intellectus humanus propendet, nempe, Dura esse maxime Densa. Nam argentum vivum fluit, aurum molle est, et plumbum. Illa vero durissimis metallis (ferro et ære) sunt densiora et graviora; lapidibus vero adhuc multo magis.

6. In Tabula multa cadunt præter opinionem: veluti quod metalla lapidibus tanto graviora; quod vitrum (corpus scilicet excoctum) crystallo (corpore conglaciato) gravius; quod terra communis tam parum ponderosa; quod olea aqua distillata vitrioli et sulphuris, ad pondus crudorum tam prope accedant; quod tam parum intersit inter pondus aquæ et vini; quod olea chymica (quæ subtiliora videri possint) oleis expressis ponderosiora; quod os sit dente et cornu tanto gravius; et alia similiter haud pauca.

Mandatum. 3. Natura Densi et Rari, licet cæteras naturas fere percurrat, neque secundum earum normas regatur, videtur solummodo magnum habere consensum cum Gravi et Levi. At suspicamur etiam eam posse habere consensum cum tarda et celeri exceptione et depositione Calidi et Frigidi. Fiat igitur experimentum, si rarius corpus non admittat et amittat calorem aut frigus celerius, densius vero tardius. Idque probetur in auro, plumbo, lapide, ligno, &c. Fiat autem in simili gradu caloris, simili quanto et figura corporis.

Vellicationes de Practica.

1. Mistura omnis corporum per Tabulam et Pondera revelari et deprehendi potest. Si enim quæratur quantum aquæ sit admistum vino, vel quantum plumbi auro, et sic de reliquis; ponderato compositum, et consule Tabulam de pondere simplicium; et mediæ rationes compositi, comparatæ ad simplicia, dabunt quantum misturæ. Arbitror hoc esse *εὕρηκα* illud Archimedis; sed utcunque ita res est.[1]

2. Confectio auri, aut transmutatio metallorum in illud, omnino pro suspecta habenda est. Aurum enim omnium corporum ponderosissimum et densissimum. Igitur, ut aliud quippiam vertatur in aurum, prorsus condensatione opus est.

[1] See for the story of Archimedes, Vitruvius, ix. 3. But I am inclined to believe that Bacon took it from Porta's *Nat. Magic*, xviii. 8. See the Preface.

Condensatio autem (præsertim in corporibus valde materiatis, qualia sunt metalla) apud nos homines in superficie terræ degentes vix superinducitur: pleræque enim ignis densationes *pseudo-densationes* sunt, si totum respicias (ut postea videbimus); hoc est, corpora in partibus aliquibus suis condensant, totum minime.

3. Verum versio argenti vivi aut plumbi in argentum (cum argentum sit illis rarius) habenda est pro sperabili; cum tantum fixationem et alia quædam innuat, non densationem.

4. Attamen si argentum vivum, aut plumbum, aut aliud metallum, verti posset in aurum quatenus ad cæteras auri proprietates, dempto pondere; ut, scilicet, fierent magis quam sunt fixa, magis malleabilia, magis sequacia, magis durabilia, et minus exposita rubigini, magis splendida, etiam flava, et hujusmodi; esset proculdubio res utilis et lucrativa, licet pondus auri non explerent.

Observatio.

7. Neque auro est ponderosius quicquam; neque ipsum aurum purum per artem (quatenus adhuc innotuit) redditur sese ponderosius.[1]

Plumbum tamen notatum est et mole et pondere augeri; præsertim si condatur in cellis subterraneis, ubi res situm facile colligunt. Id quod maxime deprehensum est in statuis lapideis, quarum pedes plumbeis vinculis erant alligati; quæ vincula inventa sunt intumuisse, ut portiones illorum ex lapidibus penderent, quasi verrucæ. Utrum vero hoc fuerit auctio plumbi, an pullulatio vitrioli, inquiratur plenius.

[1] In the original the *observatio* ends here, and the next paragraph is printed in a different type, numbered 1. and separated from the rest by a new heading, viz. *Historia*; as if it were the commencement of a new section and the introduction to the *tabula* which follows. It can hardly be doubted however that the paragraph beginning *plumbum tamen* was meant to belong to the *observatio*, and that the *Historia* is resumed with the *tabula*. The mistake may have arisen in this way: as the MS. originally stood, the *observatio* probably ended with *ponderosius*, and with it ended the discussion of the first article of inquiry, viz. the specific gravity of *different* bodies; then followed the second *tabula*, which, being the commencement of the history upon the second article of inquiry, viz. the specific gravity of the *same* bodies in different conditions, would naturally be headed *Historia* 1.: afterwards a sentence was added to the *observatio*, but being inserted in the margin, looked as if it were meant to follow the new heading, instead of preceding it. This, of course, is merely a conjecture, no part of the original MS. having been preserved. But, however the error may have arisen, it is impossible to believe that the paragraph in question was meant for an introduction to the new table, and therefore I have treated it as part of the preceding *observatio*, and printed it accordingly. — *J. S.*

[*Historia.*][1]

TABULA EXPORRECTIONIS MATERIÆ PER IDEM SPATIUM SIVE DIMENSUM, IN CORPORIBUS IISDEM INTEGRIS ET COMMINUTIS.

	Den.	Gr.		Den.	Gr.
Mercurius in corpore, quantus impleat mensuram tabularem, ponderat	19	9	sublimatus vero in pulvere presso	3	22
Plumbum in corpore . .	12	1½	in cerussa vero in pulvere presso	4	8½
Chalybs in corpore . .	8	10	in pulvere præparato (quali ad medicinas utuntur) et presso . . .	2	9
Crystallum[2] in corpore .	2	18	in pulvere presso[3] . .	2	20
Santalum rubeum in corpore	1	5	in pulvere presso . .	0	16½
Lignum quercus in corpore	0	19½	in cinere	1	2

TABULA EXPORRECTIONIS MATERIÆ PER IDEM SPATIUM SIVE DIMENSUM, IN CORPORIBUS CRUDIS ET DISTILLATIS.

	Den.	Gr.		Den.	Gr.
Sulphur in corpore . .	2	2	in oleo chymico . .	1	18
Vitriolum in corpore .	1	22	in oleo	1	21
Vinum in corpore . .	1	2⅔	in distillato . . .	0	22
Acetum in corpore[4] . .	1	3½	in distillato . . .	1	1

Monitum.[5] Modus versionis corporis in pulverem ad apertionem sive expansionem corporis multum facit. Alia enim est ratio pulveris qui fit per simplicem contusionem, sive

[1] In the fragment published by Gruter under the title *Phænomena Universi*, which will be printed in its place in Part III. of this edition, a table of specific gravities corresponding with that which follows is introduced thus: "*Continuatio Historiæ Coitionis et Expansionis Materiæ in Corpore eodem.* Rationes pulverum majore cum utilitate inquiri, si fiat collatio eorum cum corporibus ipsorum integris, quam si ponerentur per se et simpliciter, judicavimus. Hoc enim modo et de corporum diversitate et de arctissimis illis naturæ integralis nexibus et vinculis judicium fieri et rationes iniri posse animum advertimus. Intelligimus autem in rationibus pulverum pulveres fortiter et maxime pressos. Hoc enim facit ad æquationem nec recipit casum. Mercurius in corpore habet, &c." The fragment published by Gruter is fuller in this part, and apparently of later date. See note p. 258. — *J. S.*

[2] *Crystallus* in orig. — *J. S.*

[3] The table in the *Phænomena Universi* gives *denar.* 1 *gran.* 20 as the weight of *crystallum in pulvere.* — *J. S.*

[4] The table in the *Phænomena Universi* gives *denar.* 1. *gran.* 2 *d.* as the weight of *acetum in corpore.* — *J. S.*

[5] This *monitum* is numbered (6.) in the original. But if I am right in supposing that we are now dealing with a new article of inquiry, the numbers ought (according to the plan followed by Bacon in the *Historia Ventorum* and the *Historia Vitæ et Mortis*) to begin afresh. The same remark applies to the *monitum* which stands next, and which is numbered (4.) in the original, and to the two following *observationes*, which are marked in the original (8.) and (9.). — *J. S.*

limaturam; alia ejus qui per sublimationem, ut in mercurio; alia ejus qui per aquas fortes et erosionem (vertendo ea tanquam in rubiginem), ut in croco martis, et nonnihil in chalybe præparato; alia ejus qui per exustionem, ut cinis, calx. Itaque ista æquiparari nullo modo debent.

Mandatum. Indigentissimæ sunt illæ duæ tabulæ priores. Ea demum foret tabula exacta corporum cum suis aperturis, quæ corporum singulorum integrorum pondera primo, dein pulverum suorum crudorum, dein cinerum, calcium, et rubiginum suarum, dein malagmatum suorum, dein vitrificationum suarum (in iis quæ vitrificantur), dein distillationum suarum (subtracto pondere aquæ, in qua dissolvuntur), nec non aliarum eorundem corporum alterationum, pondera exhiberet: ut hoc modo de corporum aperturis, et arctissimis naturæ integralis nexibus, judicium fieri posset.

Observationes.

1. Pulveres non sunt proprie corporum aperturæ, quia augmentum spatii fit non ex dilatatione corporis, sed ex interpositione aëris; attamen per hoc optime capitur æstimatio de corporum unione interiore, aut porositate. Nam quo corpora sunt magis unita, eo major intercedit differentia inter pulverem suum et corpus integrum. Igitur ratio argenti vivi crudi ad sublimatum in pulvere est quintupla, et amplius. Rationes chalybis et plumbi non ascendunt ad quadruplam. At in corporibus levioribus et porosis, laxior quandoque est positura partium in integris, quam in pulveribus pressis; ut in ligno quercus, gravior est cinis quam corpus ipsum: etiam in pulveribus ipsis, quo corpus est gravius, eo pressus pulvis minus habet dimensum ad non pressum. Nam in levioribus, pulverum partes ita se sustentare possunt (utpote qui aërem intermistum minus premant et secent), ut pulvis non pressus triplicem impleat mensuram ad pulverem pressum.

2. Distillata plerunque attenuantur, et pondere decrescunt; sed hoc facit vinum duplo plus quam acetum.[1]

[1] Here ends the inquiry (as much at least as we have of it) upon the second article, viz. *Exporrectio materiæ in corporibus tangibilibus iisdem, integris et comminutis et crudis et distillatis.* We now enter upon a third article, viz. *Exporrectio materiæ in corporibus pneumaticis.* The first paragraph of the following *Commentatio* would probably have been described, had the work been finished, as Ad Art. 3. *Connexio.* —*J. S.*

Commentatio.

1. Atque Tangibilia per familias jam censa sunt, tanquam Divites et Inopes. Restat altera classis, videlicet Pneumaticorum. Ea vero pondere non dotantur, per cujus incubitum de exporrectione materiæ in ipsis contentæ judicium fieri possit. Opus est igitur alio quopiam interprete. At primum, species pneumaticorum proponendæ sunt; deinde comparatio facienda.

Quemadmodum in tangibilibus interiora terræ, ita in pneumaticis ætherea, ad tempus seponimus.

Sunt pneumatica apud nos triplicis naturæ; inchoata, devincta, pura. Inchoata sunt fumi omnigeni, atque ex materiis diversis. Eorum ordo esse possit; primo, volatilium, quæ expirant ex metallis et ex nonnullis fossilium; quæ sunt (prout nomen significat) potius alata quam pneumatica; quia facile admodum coagulantur, vel sublimando, vel cadendo aut præcipitando. Secundo, vaporum; qui expirant ex aqua et aqueis. Tertio, fumorum (nomine generali retento); qui expirant ex corporibus siccis. Quarto, halituum; qui expirant ex corporibus oleosis. Quinto, aurarum; quæ expirant ex corporibus mole aqueis, spiritu inflammabilibus; qualia sunt vina, et liquores exaltati, sive potus fortes.

Est et aliud genus fumorum: illi scilicet in quos flamma desinit. Ii vero non possunt expirare nisi ex inflammabilibus, cum flammam subsequantur. Hos *post-fumos*, seu *fumos secundos*, appellamus. Itaque non possunt esse *post-vapores*, quia aquea non inflammantur; sed *post-fumi* (nomine speciali), *post-halitus*, *post-auræ*; etiam, ut arbitror, *post-volatilia*, in nonnullis.

At pneumatica devincta ea sunt, quæ ipsa solitaria aut soluta non reperiuntur, sed tantum corporibus tangibilibus inclusa; quos spiritus etiam vulgo vocant. Participant autem et ex aqueo, et ex oleoso, et ex iisdem nutriuntur; quæ in pneumaticum versa, constituunt corpus veluti ex aëre et flamma; unde utriusque mysteria sunt. Accedunt autem spiritus isti (si ad pneumatica soluta spectes) proxime ad naturam aurarum, quales ex vino aut sale surgunt. Horum spirituum natura duplex; alia crudorum, alia vivorum.

Crudi insunt omni tangibili; vivi animatis tantum, sive vegetabilibus sive sensibilibus. At pneumatica pura duo tantum inveniuntur, aër et flamma; licet illa quoque magnas diversitates sortiantur, et gradus exporrectionis inæquales.

TABULA PNEUMATICORUM, SECUNDUM COMMENTATIONEM SUPRADICTAM, PROUT ORDINE ASCENDUNT AD EXPORRECTIONEM MAJOREM.

Volatilia metallorum et fossilium.	Auræ.
Post-volatilia ipsorum.	Post-auræ.
Vapores.	Spiritus crudi devincti in tangibilibus.
Fumi.	Aër.
Post-fumi.	Spiritus vivi, sive incensi, devincti in tangibilibus.
Halitus.	
Post-halitus.	Flamma.

De exporrectionibus horum, tum ad invicem tum ad tangibilia collatis, jam videndum. Atque si natura levis, per ascensum sursum, posset liquidare [1] raritatem corporum, quemadmodum natura gravis, per descensum deorsum, liquidat eorum densitatem, res bene posset succedere. Sed multa obsunt. Primo, quod differentiæ motuum in iis quæ aspectum fugiunt non percipiantur immediate per sensum: deinde, quod non reperiatur in aëre, et similibus, tam fortis appetitus petendi superiora, quam putatur: denique, si aër moveretur sursum, tamen cum continuetur plerunque cum alio aëre, motus ille ægre percipi posset. Nam sicut aqua non ponderat super aquam; ita aër non insurgit subter aërem. Itaque alii modi excogitandi sunt.

Atque de exporrectione pneumaticorum ad invicem, quodque ordo et series raritatis, qualis in Tabula ponitur, non leviter fundata sit, offerunt se quædam probationes non malæ: verum de certis gradibus hujusmodi exporrectionis, et rursus de exporrectione pneumatici comparati ad tangibile, difficilior certe est inquisitio.

Primo igitur fumos omnes, tam secundos quam primos, aëris raritatem non æquare consentaneum est; cum illi conspicui sint, aër minime; neque ipsi conspicui maneant paulo post, cum se aëri miscuerint.

Post-fumos præ-fumis esse tenuiores et rariores, satis liquet; cum sint flammæ (corporis tam subtilis) cadavera et solutiones:

[1] That is, could make clear.

experimento quoque manifestissimum est, in nocturnis spectaculis, intra cœnacula quæ tot lychnis et facibus collucent, etiam post plurium horarum moram, sufficere aërem respirationi, licet tot post-fumis in eum receptis. Quod si fuissent illi fumi præfumi (quales sunt ex lychnis et facibus extinctis, absque flamma) nemo, vel ad longe minorem moram, eos sustinere posset.

Spiritus crudos quoscunque in tangibilibus devinctos, etiam aëre densiores judicamus. Etenim spiritus vegetabilium, aut animalium mortuorum, aut hujusmodi, cum exhalaverint, manifesto retinent quiddam ex crasso, sive tangibili: ut cerni datur in odoribus; qui cum sint fumi parce exeuntes, nec conferti, ut in fumis conspicuis et vaporibus, tamen si nacti fuerint aliquid tangibile, præsertim ex mollioribus, applicant se ad illud, et plane adhærent, illudque odore inficiunt; ut manifestum sit, illos cum crassa natura affinitatem ægre dirimere.

At spiritus vivos aëre ipso aliquanto rariores existimamus: tum quia inflammantur nonnihil; tum quia diligenter experti sumus, aërem ad minuendum aut sublevandum pondus nihil conferre. Nam vesica inflata non est vacua et compressa levior, cum sit illa tamen repleta aëre; nec similiter spongia aut vellus lanæ, aëre referta, illis ipsis vacuis leviora sunt, aëre excluso. At corpus animale vivum et mortuum gravitate manifesto differunt; licet haud tantum quantum putantur. Quare videtur aër pondus non minuere; spiritus autem vivus hoc facere. Atque cum pondus densitates dijudicet, etiam levatio ponderis raritates dijudicare debet.

Supremo ordine collocatur flamma; tum quia illa manifestissime petit superiora; tum quia verisimile est, rationes pneumaticorum minime differre a rationibus fomitum suorum; ideoque, quemadmodum oleum est rarius aqua, similiter flammam rariorem esse aëre et spiritu. Etiam videtur flamma corpus tenuius et mollius et magis cedens, quam aër. Nam levissima quæpiam aura, commota juxta flammam lychni, eam reddit tremulam.[1]

[1] Here, I think, should have followed the *Historia*, properly so called (for the preceding observations are but preparatory considerations), of the expansion of pneumatical bodies compared with one another. But it seems to have been lost or never written, for all that relates to the *Exporrectiones pneumaticorum ad invicem collatæ* ends here, and the *Historia* which follows relates to the *pneumaticum collatum ad tangibile.*

The two next paragraphs are printed in italic in the original, headed *Historia*, and numbered (2.) and (3.). These numbers are connected probably with the portion of

Historia.

1. Quantam vero expansionem assequatur Pneumaticum collatum ad Tangibile, licet sit res ardua inventu, tamen curam de ejus inquisitione non abjecimus. Certissima autem visa est nobis fore probatio, si corpus aliquod tangibile (exporrectione ejus prius capta et mensurata) verti posset plane in pneumaticum, et deinde pneumatici illius exporrectio itidem notaretur; ut pensitatis utriusque rationibus, de multiplicatione dimensi evidens demonstratio fieri posset.

2. Accepimus igitur phialam vitream parvam, quæ unciam fortasse unam capere posset. In eam spiritus vini (quia ex liquoribus proxime accedebat ad pneumaticum, cum esset levissimus) unciam dimidiam infudimus. Deinde vesicam accepimus admodum grandem, utpote quæ octo pintas vinarias (*galonium* scilicet, ut nostrates appellant) capere posset. Vesica autem erat non vetus; et propterea non sicca et renitens, sed recens et mollis. Ex illa vesica aërem omnem, quoad fieri potuit, expressimus; ut latera ejus essent quasi contigua et cohærentia. Vesicam insuper per exterius oleo parum oblevimus, et molliter fricavimus; ut porositas vesicæ oleo obturaretur, atque etiam ut inde fieret magis cedens et tensibilis. Hanc circa os phialæ (ore scilicet phialæ intra os vesicæ recepto) applicuimus; eamque filo cerato arcte ligavimus. Tum demum phialam supra prunas ardentes in foculo collocavimus. Non ita multo post ascendebat aura spiritus vini in vesicam, eamque paulatim undequaque fortiter admodum inflavit. Quo facto, continuo vitrum ab igne removimus; et in summitate vesicæ foramen acu fecimus, ut aura potius expiraret, quam relaberetur in guttas. Deinde vesicam a phiala sustulimus, et per lances quantum de illa semiuncia spiritus vini diminutum fuisset, et in auram versum, probavimus. Erat autem deperditum non plus (pondere) denariis sex. Adeo ut sex illi denarii in corpore spiritus vini, qui quadragesimam partem pintæ (ut memini) non implebant, in auram versi spatium octo pintarum adæquarent.

Historia in the preceding section, which is numbered (1.). The paragraphs which follow, to the end of this part, are not numbered at all, though distinguished by headings. As they all appear to belong properly to the present article of inquiry, I have numbered them consecutively from this place, and omitted the separate headings, which under the arrangement which I have adopted are unnecessary; the general heading which I have inserted within brackets applying to them all. — *J. S.*

Monitum. Memini etiam vesicam ab igne remotam paulum flaccescere incepisse; ut, non obstante tam insigni expansione, non videretur tamen aura versa fuisse in pneumaticum purum et fixum, cum ad se restituendam inclinaret. Attamen fallere possit hoc experimentum, si ex eo conjiciamus aërem communem esse adhuc hujusmodi aura rariorem; quoniam arbitramur spiritum vini in pneumaticum versum (licet minime purum) tamen propter calorem, superare raritatem aëris frigidi; cum et ipse aër per calorem majorem in modum dilatetur, et exporrectionem aëris frigidi haud paulum superet. Itaque arbitramur, si experimentum fiat in aqua[1], multo minorem futuram expansionem; licet corpus aquæ plus materiæ contineat quam spiritus vini.

3. Si advertas fumum ex cereo recenter extincto exeuntem, et oculis metiaris crassitudinem ejus, et rursus intuearis corpus ipsius fumi postea inflammati; videbis expansionem flammæ, collatæ ad fumum, ampliatam quasi ad duplam.

Monitum. Si accipias pauca grana pulveris pyrii, eaque inflammes, magna prorsus fit expansio respectu corporis pulveris. Sed rursus, extincta illa flamma, multo amplius adhuc se extendit corpus fumi. Id vero non te fallat, ac si corpus tangibile plus expanderetur in fumo, quam in flamma; nam id secus se habet. Sed ratio apparentiæ est, quod corpus flammæ sit corpus integrum, corpus fumi corpus commistum, ex longe majore parte, cum aëre; itaque, sicut parum croci multum aquæ colorat, similiter parum fumi in multum aërem se spargit. Nam fumus spissus (ut antea dictum est) non sparsus, minor cernitur corpore flammæ.

4. Si accipias frustulum corticis arantii exterioris (qui aromaticus est, et oleosus), ipsumque subito comprimas juxta lychnum, exilit aliquid roris in guttulis; quod tamen constituit corpus flammæ (respectu guttularum) insigniter amplum.

[1] In the *Phænomena Universi* we have a very exact account of this same experiment tried with water. The result of a comparison of the two experiments was, that the expansion of the vapour of spirits of wine was a little more than five times as great as that of vapour of water. I have thought this the rather worth mentioning, because the fact that Bacon, when he wrote the tract printed by Gruter, had tried this experiment with water as well as with spirits of wine, whereas when he wrote this *monitum* he had clearly not tried it with water, seems to prove that Gruter's copy of *this part* of the treatise is the later of the two; and therefore, if any one wishes ascertain the exact worth of Bacon's labours in this matter, he must take both the writings together.—*J. S.*

Observatio.

Commentum illud Peripateticorum de decupla proportione elementorum ad invicem in raritate, res fictitia est, et ad placitum; cum certum sit, aërem centuplo (ad minimum) rariorem esse aqua, flammamque oleo; at flammam ipsum aërem decupla minime superare.[1]

Monitum. Non est cur ista inquisitio et commentatio circa pneumatica videatur cuipiam nimis subtilis aut curiosa. Certum enim est, omissionem et inobservantiam circa illa obstupefecisse philosophiam et medicinam, easque tanquam siderasse; ut fuerint ad veram causarum investigationem attonitæ et quasi inutiles, qualitatibus tribuendo quæ spiritibus debentur: ut in titulo proprio de pneumatico ipso fusius apparebit.[2]

Connexio.

ATQUE de exporrectione materiæ in corporibus secundum consistentias suas diversas, dum quiescunt, hæc inquisita sint. De appetitu autem et motu corporum, unde tumescunt, residunt, rarefiunt, condensantur, dilatantur, contrahuntur, majorem, minorem locum occupant, accuratius, si fieri possit, inquirendum; quia fructuosior est inquisitio, naturam simul et revelans et regens. Attamen carptim facienda est inquisitio ista, et cursim. Iste enim titulus, de Denso et Raro, tam generalis est, ut si plenarie deductus foret, multa ex sequentibus titulis anticipaturus esset, quod fieri non oportet.

Monitum. Non difficile nobis foret Historiam (quam jam subjungemus) Sparsam in ordinem meliorem quam qua usi sumus redigere, instantias quæ inter se affines sunt simul collocando. Id consulto evitavimus, duplici ratione moti. Primo, quod multæ ex instantiis ancipitis naturæ sint, et ad plura spectent; itaque ordo accuratus in ejusmodi rebus aut iterat aut fallit. Deinde (id quod præcipue in causa fuit cur

[1] See the note on *Nov. Org.* l. 45.

[2] Here ends the first part of the treatise, relating to the specific gravities of different bodies, or the same bodies in different conditions, *when at rest;* which I take to be altogether imperfect and fragmentary. The rest is much more complete, and set forth more orderly. It seems however that it ought to have been divided from what goes before by a separate title, *De Dilatationibus et Contractionibus Corporum.*—*J. S.*

a methodo aliqua exacta abhorremus) hoc quod agimus omnium industriæ ad imitationem patere volumus. Quod si methodo aliqua artificiali et illustri collectio ista instantiarum connexa fuisset, desperassent proculdubio complures se ejusmodi inquisitionem facere potuisse. Quare et exemplo et monito cavemus, ut quisque in instantiis comparandis et proponendis suo judicio, suæ memoriæ, suæ copiæ inserviat. Satis sit si de scripto et non memoriter (id enim in tantis instantiarum fluctibus ludicrum quiddam esset) semper procedat inventio; ut veræ inductionis lumine postea absolvi possit. Atque illud perpetuo memoria tenendum, nos in hoc opere stipem tantummodo et tributum a sensu ad ærarium scientiarum exigere; neque exempla ad illustranda axiomata, sed experimenta ad ea constituenda, proponere. Neque tamen dispositionem instantiarum prorsus negligemus, neque discincti hoc aggrediemur; sed ita instantias collocabimus, ut sibi invicem lucem præbeant nonnullam.

Historia Sparsa.

1. Ex introceptione corporis alieni nil mirum si sequatur dilatatio corporis alicujus; quandoquidem hoc sit plane augmentum sive additio, non rarefactio vera. Attamen cum corpus quod introcipitur fuerit pneumaticum (veluti aër, aut spiritus), aut etiam cum corpus introceptum, licet fuerit tangibile, tamen sensim illabatur et se insinuet; vulgo habetur magis pro tumore quodam quam accessione.

DILATATIONES PER INTROCEPTIONEM SIMPLICEM, SIVE ADMISSIONEM CORPORIS NOVI.[1]

2. Vesica, aut alia tensilia (ut folles), inflantur aëre integro, atque extenduntur; adeo ut indurentur, et ictum, jactum, pati possint: etiam bulla aquæ est instar vesicæ, nisi quod est tam fragilis.

3. Liquores de vase in vas de alto fusi, aut cochlearibus et spatulis aut ventis fortiter agitati, committuntur et commi-

[1] I am inclined to think that this heading and the last, ought properly to change places, the preceding paragraph being rather a *monitum* than an article of the *Historia Sparsa*. I have not ventured to make so great an alteration in the order of the text as it stands in the original. But I have little doubt that the arrangement which will be found a little further on in a similar case (see p. 266.) is that which ought to be adopted here.—*J. S.*

scentur cum aëre; unde se attollunt in spumam. Illi paulo post residunt, et minorem locum occupant, aëre (fractis spumæ bullulis) exeunte.

4. Extruunt pueri ex aqua saponi admista (unde fit paulo tenacior) turres bullatas; adeo ut parum admodum aquæ (aëre introcepto) magnum locum occupet.

5. At non invenitur quod flamma, per inflationem follium aut agitationem aliam exteriorem, cum aëre misceatur et spumescat, in eum modum ut possit constitui corpus commistum ex flamma et aëre, instar spumæ, quæ commista est ex aëre et liquore.

6. At contra, certum est, per mistionem interiorem in corpore antequam inflammetur, fieri posse corpus commistum ex aëre et flamma. Nam pulvis pyrius habet partes non inflammabiles ex nitro, alias inflammabiles præcipue ex sulphure: unde etiam magis albicat et pallescit quam cæteræ flammæ (licet flamma ipsa sulphuris vergat ad cæruleum): adeo ut possit illa flamma recte comparari spumæ potentissimæ, ex flamma et aëre coagmentatæ, sive vento cuidam igneo.

7. Quemadmodum autem spuma est corpus compositum ex aëre et liquore; ita etiam pulveres omnes sunt compositi ex aëre et minutiis corporis pulverizati; ut non aliter differant a spumis, quam contiguum differt a continuo: nam magna moles ipsorum consistit ex aëre, qui partes corporis sublevat; ut ex Tabula secunda et tertia liquet.

8. Fiunt tumores in ventre animalium et aliis partibus, ex flatu et humore aqueo introcepto et admisso; ut in hydrope, tympanite, et similibus.

9. Est genus columbarum, quod, capite intra collum recepto, inflatur et tumet.

10. Respiratio per pulmones (follium instar) aërem attrahit et reddit; dilatante se per vices pulmone, et residente.

11. Fœmellæ prægnantes tument mammillas, lacteo scilicet humore turgentes.

12. Glans virgæ in masculis, cum arrigitur in venerem, multum dilatatur mole.

13. Inspice in speculum, et nota latitudinem utriusque oculi pupillæ; dein claude alterum oculum; et videbis pupillam oculi aperti manifeste dilatatam, spiritibus qui utrique oculo inserviebant in unum confluentibus.

14. Rimæ globorum lusoriorum, et similiter lignorum alio-

rum, a siccitate contractæ, per immissionem et moram nonnullam in aqua, et imbibitionem ipsius aquæ, implentur et consolidantur.

15. Est genus quoddam fungi qui excrescit ex arbore, quem vocant *Auriculam Judæi,* qui immissus in aquam magnopere intumescit: quod non facit spongia aut lana.

Connexio.

ATQUE de introceptionibus corporis alieni (quæ sunt pseudo-rarefactiones) hæc inquisita sint. Transeundum ad dilatationes et tumores quæ fiunt in corporibus ex spiritu innato (sive illi sunt naturales, ut loquuntur, sive præternaturales) absque igne aut calore manifesto externo: licet in his quoque sequatur quandoque accessio sive introceptio humoris, præter ipsam dilatationem simplicem.

DILATATIONES PER SPIRITUM INNATUM SE EXPANDENTEM.

[*Historia.*][1]

1. Mustum, aut cervisia nova, et similia, in doliis reposita, intumescunt et insurgunt admodum; adeo ut, nisi detur spiraculum, dolia infringant; sin detur, se attollant, et exundent cum spuma, et quasi ebulliant.

2. Liquores spirituosi arctius conclusi (ut in utribus fortiter obturatis) magno impetu sæpe erumpunt, et opercula sua quandoque ejiciunt, tanquam e tormento.

3. Audivi mustum nuper calcatum, et quasi fervens, in vitro crasso et forti repositum (ore vitri bene lutato et clauso, ut mustum nec erumpere nec perfringere posset) non reperiente exitum spiritu, se per continuas circulationes et vexationes vertisse plane in tartarum; ut nihil restaret in vitro, præter auram et fæces: verum de hoc mihi parum constat.

4. Semina plantarum, ut pisorum, fabarum, et ejusmodi, turgescunt nonnihil, antequam emittant radicem aut caulem.

5. Arbores quandoque, spiritu et succo nativo tumescentes, corticem rumpunt, et emittunt gummi et lacrymas.

[1] The thirty-two paragraphs which follow are numbered in the original 16—47.; the last paragraph of the *Historia* in the previous section being numbered 15. As they clearly belong to a fresh division of the inquiry, I have followed modern editors in giving them a fresh series of numbers. It will be seen as we proceed, that the numeration of these paragraphs in the original is not conducted upon any consistent or intelligible plan. — *J. S.*

6. Etiam gemmæ complures videntur esse eruptiones succorum puriorum ex rupibus; cum tam gummi quam gemmæ rupium deprehendantur (ex splendore) esse succi percolati et depurati; adeo ut etiam saxa et lapides videantur ex spiritu innato tumescere.

7. Neque dubium est, quin in spermate animalium primus actus ad vivificandum sit quædam expansio massæ.

8. Vitriolum erumpendo tanquam germinat, et fere arborescit.

9. Lapides tempore et senio (præsertim in locis humidioribus) emittunt salem, qui est ex natura nitri.

10. Omnis gleba terræ tumet nitro: itaque si terra quævis sit cooperta et accumulata, ita ut succus ejus non exhauriatur per solem et aërem, nec se consumat in emittendo vegetabili, colligit nitrum, ut internum tumorem. Ideo in aliquibus Europæ partibus struunt mineras artificiales nitri, accumulata terra, in domibus ad hoc paratis, prohibito aditu solis.[1]

11. Sudores in animalibus, per motum dilatatis spiritibus, atque humoribus veluti liquefactis, proveniunt.

12. Pulsus cordis et arteriarum in animalibus fit per irrequietam dilatationem spirituum, et receptum ipsorum, per vices.

13. Quin et motus voluntarius in animalibus, qui expeditur (in perfectioribus) per nervos, videtur radicem habere in compressione primum, deinde relaxatione, spirituum.

14. In omni contusione membri alicujus in animalibus sequitur tumor: idem evenit in plerisque doloribus.

15. Aculei vesparum et apum majorem inducunt tumorem, quam pro inflictu: id multo magis faciunt punctiones serpentum.

16. Etiam urtica, bryonia, et alia nonnulla, levant cutem, et vesicas in illa causant.

17. Habetur pro evidenti signo veneni (præsertim ejus generis quod operatur ex qualitate maligna, non per erosionem) si facies aut corpus intumescat.

18. In vesicationibus colli aut alterius alicujus partis, quæ adhibentur ad curationes morborum, assurgit humor aqueus, sive ichor, qui postea, cute scissa aut puncta, effluit.

19. Omnes pustulæ ex causa interna, et hujusmodi efflore-

[1] See Beckmann's Hist. of Inventions, ii. p. 479.

scentiæ et apostemata, inducunt tumores apparentes, et sublevant cutem.

20. Iracundia subito effervescens (in nonnullis) inflat buccas: similiter et fastus.

21. Ranæ et bufones tument; et complura animalia per ferociam erigunt cristas, et pilos, et plumas: quod fit ex contractione cutis per tumorem spirituum.

22. Galli, quos Indicos, alii Turcicos vocant, irati magnopere tument, et pennas tanquam jubas erigunt. Aves cum dormitant, dilatato spiritu per receptum caloris ad interiora, nonnihil tument.

23. In omni carie et putredine tumescere incipiunt spiritus corporis innati; cumque ad exitum properant, solvunt et alterant rei compagem; et, si compages rei sit paulo tenacior et viscosior, ut exire non possint, novas formas moliuntur, ut in vermibus e putredine natis; sed exordium actionis est a dilatatione spirituum.

24. Neque spiritus in putredine cohibitus tantum molitur animalcula, verum et rudimenta plantarum: ut conspicitur in musco, et hirsutie arborum nonnullarum. Memini me expertum esse, casu quodam non de industria, quod cum æstivo tempore malum citrium, ex parte sectum, in conclavi reliquissem, post duos menses inveni in parte secta putredinem quandam germinantem; adeo ut in capillis quibusdam exurgeret ad altitudinem pollicis, ad minus, atque in summitate capillorum singulorum adscivisset caput quoddam, instar capitis pusilli clavi; plane incipiens imitari plantam.[1]

25. Similiter, rubigines fiunt in metallis et vitro et similibus, ex dilatatione spiritus innati, qui tumescit, et urget partes crassiores, easque ante se agit, et extrudit, ut exeat.

26. Utrum terra in superficie tumescat, præsertim ubi glebæ sunt spongiosæ et cavæ, inquirendum. Certe inveniuntur quandoque in ejusmodi glebis arbores instar malorum navium, quæ sub terra, nonnullos pedes in altum, jacent demersæ et sepultæ: ut verisimile sit arbores illas per tempestates fuisse olim dejectas; postea vero, attollente se paulatim terra, coopertas fuisse et sepultas.

27. At subito et manifeste intumescit terra in terræ motibus, unde sæpenumero erumpunt scaturigines aquarum, vortices, et

[1] Compare *Sylva Sylvarum*, 606., where it is said that the lemon was left for three months.

globi flammarum, venti vehementes et peregrini, atque ejiciuntur saxa, cineres.

28. Neque tamen terræ motus omnes prorsus subito fiunt; nam evenit nonnunquam ut terra contremuerit per plures dies: et nostro tempore apud nos in agro Herefordiensi fuit terræ motus, admodum pusillus et lentus, sed rarus; in quo aliqua jugera terræ per diem integrum paulatim se moverunt, et in alium locum paulo decliviorem, nec multo distantem, se transtulerunt, et ita qnieverunt.

29. Utrum moles aquarum in maribus aliquando tumescant, inquirendum. Nam in ipsis fluxibus maris, necesse est ut illi fiant vel ex motu progressivo, vel ex sublatione aquarum in sursum per virtutem et consensum aliquem magneticum, vel denique per tumorem sive relaxationem aliquam in ipsis aquis. Atque postremus iste modus (si modo talis aliquis sit inter causas fluxus alicujus) pertinet ad inquisitionem præsentem.

30. Aqua in fontibus et puteis nonnullis tumescit et residit; adeo ut æstus quosdam videatur pati.

31. Etiam erumpunt quandoque in quibusdam locis scaturigines aquarum, absque aliquo terræ motu, intra aliquos annos, ex causis incertis. Fitque ista eruptio plerunque in magnis siccitatibus.

32. Etiam notatum est, intumescere quandoque maria absque fluxu aut vento aliquo exteriore; idque fere tempestatem aliquam magnam præcedere.

Mandata. Non foret indignum experimento, ut probetur utrum fiat interdum aliqua relaxatio in corpore aquæ, etiam in minore quanto. Atqui si exponatur aqua soli vel aëri, fiet potius consumptio: itaque experimentum faciendum in vitro clauso. Accipe itaque vitrum, quod habeat ventrem amplum, collum vero longum et angustum, atque infundatur aqua, donec venter et pars inferior colli impleatur. Fiat autem hoc per tempestatem aëris borealem et siccam; atque ita permittatur, donec succedat tempestas australis et pluviosa; et vide, si aqua insurgat aliqualiter in collo vitri. Etiam de tumoribus aquæ in puteis facienda est diligentior inquisitio; utrum fiant magis noctu quam interdiu, et quali tempestate anni.

33.[1] In pinnis fidium ligneis fit, tempore pluvioso, ut illæ

[1] The seven paragraphs which follow are headed *Historia* in the original, and numbered 1—7. As they are obviously a continuation of the same inquiry, I have followed Mr. Montagu in continuing the numbers and omitting the heading.—*J. S.*

tumescentes difficilius torqueantur. Similiter pyxides ligneæ difficilius extrahuntur ex thecis suis, et ostia lignea difficilius aperiuntur.

34. Chordæ fidium extentæ paulo rigidius temporibus pluviosis rumpuntur.

35. Humores in corporibus animalium, tempestatibus australibus et pluviosis, deprehenduntur laxari et tumescere, et fluere, et incumbere magis, et meatus obstruere.

36. Recepta est opinio, humores et succos, non in animalibus tantum sed et in plantis, sub pleniluniis magis turgescere, et cava implere.[1]

37. Sales in locis humidis se solvunt, aperiunt, et dilatant: id quod faciunt (aliqua ex parte) saccharum et condita; quæ, nisi reponantur in cameris ubi aliquando accenditur ignis, situm colligunt.

38. Etiam omnia quæ per ignem cocta et majorem in modum contracta sunt, tractu temporis nonnihil laxantur.

39. De tumoribus et relaxationibus aëris diligentius videndum; et quatenus in his militent (magna ex parte) causæ ventorum; cum vapores nec colliguntur commode in pluviam, nec dissipantur in aërem limpidum, sed inducunt tumores in corpore aëris.

Connexio.

ATQUE de dilatationibus corporum per spiritum innatum, sive in maturationibus, sive in rudimentis generationum, sive in excitatione per motum, sive in irritationibus naturalibus aut præternaturalibus, sive in putrefactionibus, sive in relaxationibus, hæc pauca ex cumulo naturæ inquisita sunto. Transeundum jam ad aperturas et dilatationes quæ fiunt per ignem et calorem externum actualem.

DILATATIONES ET APERTURÆ CORPORUM, QUÆ FIUNT PER IGNEM ET CALOREM ACTUALEM, SIMPLICEM, EXTERNUM.

Monitum. Aperturæ corporum per calorem sive ignem (de quibus jam inquiremus) proprie spectant ad titulos de Calido et Frigido, et de Motu Hyles, et de Separationibus et Alterationibus. Attamen carpendum et prægustandum est

[1] Thus Rattray says, "omnia bulbosa inter herbas et cucumeracea lunæ incrementum et decrementum servant accrescendo et decrescendo, item ostracea, et pupilla oculi cati." — *Theatrum Sympathet.* p. 28.

aliquid ex ipsis in præsenti titulo, cum absque aliqua notitia ipsorum non possit inquiri recte de Denso et Raro.

Historia.

1. Aer per calorem dilatatur simpliciter. Neque enim separatur quippiam aut emittitur, ut in tangibilibus; sed simpliciter fit expansio.

2. In ventosis, vitro et aëre intra ipsum contento calefactis et ventosis carni applicatis, quando paulo post aër, qui per calorem dilatatus fuerit, remittente calore se recipiat paulatim et contrahat, attrahitur per motum nexus caro. Quod si ventosas fortius attrahere cupias, accipe spongiam frigida madefactam, et pone eam super ventrem ventosæ; ut, per refrigerationem amplius contracto aëre, ventosa fortius attrahat.

3. Accipe vitrum, et calefacias illud: mitte illud post in aquam: attrahet aquam pro minimo ad tertias contenti; unde liquet, aërem a calore rarefactum fuisse pariter ad tertias contenti. Sed hoc parum est. Nam cum vitrum quo usi sumus tenue esset, majorem calefactionem absque periculo rupturæ non facile patiebatur. Quod si fuisset phiala ferrea aut ænea, et majorem in modum calefacta, arbitror aërem posse dilatari ad duplum aut triplum: quod experimento dignissimum est; etiam ad quousque; ut inde melius de raritate aëris superne, atque adeo ætheris ipsius, judicium facere possimus.

4. In *vitro* quod appellamus *calendare* (quod tempestatum, quatenus ad calorem et frigus, tam accurate demonstret varietates et gradus), evidentissime patet quam parva accessio caloris expandat aërem notabiliter; adeo ut manus vitro superposita, radii aliqui solis, ipse anhelitus astantium operetur: quin et ipsius aëris externi inclinationes ad calorem et frigus (tactui ipsi imperceptibiles) aërem nihilominus in vitro sensim et perpetuo dilatent et contrahant.

5. Hero describit altaris fabricam, eo artificio, ut superimposito holocausto et incenso, subito aqua descenderet, quæ ignem extingueret. Id non aliam poscebat industriam, quam ut sub altare esset locus concavus et conclusus, aëre repletus; qui aër ab igne calefactus et propterea dilatatus nullum reperiret exitum, nisi in canali ad parietem altaris erecto et curvato, ore super altare inverso. In canali erecto infusa erat aqua (facto etiam ventre in canali, ut largior copia aquæ reciperetur): ea aqua obice impediebatur, ne descenderet, forami-

nato; qui obex postquam erat versus, dabat locum aëri dilatato, ut aquam eveheret et ejiceret.[1]

6. Inventum fuit Fracastorii ad excitandos apoplecticos, ut poneretur sartago fervens circa caput ad nonnullam distantiam; unde spiritus in cellis cerebri suffocati et congelati, et ab humoribus obsessi, dilatarentur, excitarentur, et vivificarentur.[2]

7. Etiam papiliones, quæ hieme jacent emortuæ, admotæ ad ignem aut radios solis, motum et vitam recipiunt. Ægroti quoque in deliquiis, tam aquis fortibus et calidis intro sumptis, quam calore exteriore, et fricationibus, et motu excitantur.

8. Apertura aquæ talis est. Sub primo calore emittit vaporem paucum et rarum: neque intra corpus alia conspicitur mutatio. Continuato calore, corpore integro non insurgit, nec etiam bullis minutis in modum spumæ; sed per bullas majores et rariores ascendit, et in copiosum vaporem se solvit. Ille vapor, si non impediatur aut repercutiatur, aëri se immiscet; primo conspicuus, dein insensibilis et se deperdens.

9. Apertura olei talis est. A primo calore ascendunt guttulæ quædam aut granula per corpus olei sparsa; idque cum crepitatione quadam. Interim nec bullæ in superficie ludunt (ut in aqua), nec corpus integrum tumet, nec quicquam fere halitus evolat. At post moram nonnullam, tum demum corpus integrum insurgit, et dilatatur expansione notabili, tanquam ad duplum; et copiosissimus et spissus admodum evolat halitus. Is halitus, si flammam interea non conceperit, miscet se tandem cum aëre, quemadmodum et vapor aquæ. Majorem autem calorem desiderat, ad hoc ut bulliat, oleum quam aqua, et tardius multo bullire incipit.

10. Apertura spiritus vini ea est, ut aquam potius referat quam oleum. Nam ebullit, magnis utique bullis, absque spuma aut totius corporis elevatione; longe autem minore calore, et multo celerius expanditur et evolat, quam aqua. Utriusque vero naturæ particeps (tam aqueæ scilicet quam oleosæ), et facile se immiscet aëri, et cito concipit flammam.

11. Acetum et agresta et vinum in hoc differunt in processu suæ aperturæ: quod acetum insurgat in minoribus bullis, et magis circa latera vasis; agresta et vinum in majoribus bullis, et magis in medio vasis.

12. Generaliter in liquidis hoc fit, ut pinguia, sicut oleum,

[1] Hero, Spiritalia, c. 11. See Commandine's translation (1583), p. 44.
[2] See the note on *Nov. Org.* ii. § 35., Vol. I. p. 291.

lac, adeps, et hujusmodi, insurgant et tumeant simul toto corpore; succi maturi (et magis adhuc immaturi) bullis majoribus; succi effœti et vapidi bullis minoribus.

13. Omnibus liquoribus commune est, etiam oleo ipsi, ut antequam bulliant, paucas et raras semibullas circa latera vasis jaciant.

14. Omnibus liquoribus commune est, ut in parva quantitate citius aperiantur, bulliant, atque consumantur, quam in magna.

Monitum. Experimentum de aperturis liquorum faciendum est in vasis vitreis, ut motus in corpore liquorum melius conspici possint; atque super foculos cum calore æquali, ut differentia verius excipiatur; atque igne lento, quia ignis vehemens præcipitat et confundit actiones.

15.[1] Sunt vero complura corpora, quæ non sunt liquida, sed consistentia et determinata; attamen per calorem nanciscuntur eam aperturam, ut liquescant sive deveniant liquida, quamdiu calor ea vellicet et expandat; qualia sunt cera, adeps, butyrum, pix, resina, gummi, saccharum, mel; et plurima ex metallis, veluti plumbum, aurum, argentum, æs, cuprum. Ita tamen, ut ad aperturam requirantur non solum gradus caloris longe diversi, sed et modificationes ignis et flammæ dissimiles. Nam alia metalla colliquantur per ignem simpliciter, ut plumbum; alia per ignem motum et follibus excitatum, ut aurum et argentum; alia non sine admistione, ut chalybs; qui non nisi admisto sulphure aut simili quopiam colliquatur.

16. At ista omnia, si continuetur ignis et urgeat, non solum sortiuntur aperturam colliquationis, sed pertranseunt, et adipiscuntur secundam aperturam (volatilis scilicet, sive pneumatici, sive consumptionis); omnia, inquam, præter aurum: nam quatenus ad argentum vivum, cum in natura sua sit liquidum, incipit illud ab apertura secunda, et facile vertitur in volatile. De auro adhuc dubium est, utrum possit fieri volatile aut pneumaticum, (aut etiam potabile, ut loquuntur); hoc est, non dissolubile quidem (id enim facile est et tritum per aquas fortes), sed digestibile aut alterabile per ventriculum humanum. Hujus autem rei legitima videtur probatio, minime illa, ut vi ignis ascendat aut trudatur sursum, sed ut ita attenuetur et subigatur, ut restitui in metallum non possit.

[1] Here again we find in the original a fresh heading and a fresh series of numbers. I have again followed the example of Mr. Montagu in continuing the series. — *J. S.*

17. Inquiratur etiam ulterius de vitro et vitrificatis, utrum per ignem consumantur et vertantur in pneumaticum. Habetur enim vitrum pro corpore fixo et exucco; et vitrificatio pro morte metallorum.

18. Quæ colliquantur omnia, in via et processu suo incipiunt ab infimo illo gradu aperturæ, qui est emollitio et inteneratio, antequam colliquentur et fundantur; ut cera, gummi, metalla colliquabilia, vitrum, et similia.

19. At ferrum et chalybs, postquam fuerint perfecta et repurgata (nisi fuerit admistio) quatenus ad ignem simplicem, persistunt, et non procedunt ultra illum gradum emollitionis, ut reddantur scilicet malleabilia et flexibilia, et exuant fragilitatem suam; minime autem pertingunt ad colliquationem sive fusionem.

20. Videntur ferrum et vitrum, cum aperiuntur ad illam mollitiem de qua diximus, dilatari sane in spiritu suo incluso; unde fit illa subactio partium tangibilium, ut duritiem et obstinationem suam deponant; neque tamen corpus ipsum integrum localiter dilatari aut intumescere cernitur. Attamen attentius paulo inquirenti, deprehenditur plane in ipsis invisibilis quidam tumor et partium pulsatio; licet cohibeatur ab arcta compage sua. Nam si accipias vitrum ignitum, et majorem in modum calefactum, et ponas illud supra tabulam lapideam aut simile aliquod corpus durum, (licet et ipsa tabula illa seu corpus bene calefactum fuerit, ut frigori causa imputari non possit) rumpetur prorsus vitrum, duritie lapidis scilicet tumorem illum occultum vitri repercutiente. Itaque solent in hujusmodi casu, quando vitrum fervens summovetur ab igne, substernere ipsi pulverem aliquem aut arenam mollem, quæ suaviter cedens tumorem in partibus vitri non retundat.

21. Etiam pilæ e bombardis emissæ, postquam non solum vehi, sed et gliscere aut labi omnino desierint, adeo ut ad aspectum sint prorsus immobiles, tamen diu post, magnum deprehenduntur habere tumultum et pulsationem in minimis; adeo ut, si aliquid superponatur, magnam vim patiatur: neque id tam a calore comburente, quam a palpitatione percussiva.

22. Bacula lignea recentia, sub cineribus calidis detenta et versata, induunt mollitudinem, ut melius flectantur ad arbitrium. Experire quid fiat in baculis antiquioribus et in cannis.

23. Apertura combustibilium ea est, ut per ignem primo

emittant fumum, dein concipiant flammam, postremo deponant cinerem.

24. In corporibus quæ continent humorem aqueum et a flamma abhorrentem in compage clausa et compacta (qualia sunt folia lauri, et alia non porosa, sales et similia), ea est apertura per ignem, ut spiritus in iis contentus (aqueus et crudus), per calorem dilatatus, cum sonitu emittatur antequam flamma concipiatur: si vero in aliquo corpore (quod raro fit) insimul fiant et eruptio flatus et conceptio flammæ, ingens tumultus excitatur, et potentissima dilatatio; flatu, tanquam internis follibus, flammam undiquaque exufflante et expandente, ut in pulvere pyrio.

25. Panis in furno nonnihil tumescit, licet fiat minoris ponderis quam ante: etiam in summo panis quandoque colligitur tanquam bulla aut vesica crustæ; ut cavum quiddam aëre impletum maneat inter pelliculam illam crustæ (quæ exscindi solet) et massam panis.

26. Etiam carnes assatæ nonnihil tument, præsertim si maneat epidermis, ut in porcellis.

27. At fructus assati quandoque exiliunt, ut castaneæ; quandoque effringunt corticem, et emittunt pulpam, ut poma; quod si ab igne magis torrefiant, asciscunt crustam carbonariam, ut cavum sit quiddam (ut in pane) inter crustam et carnem fructus; quod et fit in ovis.

28. Si vero calor sit lenis et cæcus, nec detur spiraculum facile ad emittendum vaporem, ut fit in pyris sub cinere assatis, et multo magis in iis quæ reponuntur in ollis, atque deinde sub cinere sepeliuntur, atque similiter in carnibus suffocatis, vel inter crustas panis vel patinas; tum tumor ille et dilatatio per calorem repellitur et in se vertitur, atque tanquam in distillatione restituitur, et reddit corpora magis humectata, et tanquam mersa in succis suis.

29. At in aridis, si flamma fuerit suffocata nec facilem reperiat exitum, rarefiunt corpora, et redduntur cava et porosa, ut in carbonibus e ligno, et pumicibus quæ ejiciuntur ex montibus flammantibus.

Connexio.

TRANSEUNDUM jam esset ad dilatationes et aperturas corporum quæ fiunt per calorem in distillationibus; in quibus magis accurate datur cernere hujusmodi aperturas, quam in

coctionibus et ustionibus. Verum cum in illis immorari haud parum oporteat, cumque proprie pertineat inquisitio ipsarum ad titulos de Calido et Frigido, et de Motu Hyles, et de Separationibus, exiguum quiddam est quod proponi debet in hoc titulo.

DILATATIONES PER CALOREM EXTERNUM IN DISTILLATIONIBUS.

1. Duplex est dilatatio, sive apertura, sive attenuatio corporum in distillationibus. Altera in transitu, cum corpus vertitur in vaporem aut fumum (qui postea restituitur); altera in corpore restituto, quod semper tenuius est et magis subtile et expansum et minus materiatum, quam corpus crudum ex quo distillatum emanavit. Aqua enim rosacea (exempli gratia) est succo rosarum tenuius et minus ponderosum.

2. Distillationes omnes fiunt ex æstu quodam sive reciprocatione rarefactionis primo, et versionis in pneumaticum; dein condensationis et restitutionis in corpus tangibile, remittente se calore et vapore repercusso.

3. In distillationibus actiones dilatationis et condensationis non sunt sinceræ; sed intervenit actio illa (quæ maxime est intentionalis in practica) separationis partium heterogenearum; ut succi veri, phlegmatis, aquæ, olei, partis tenuioris, partis crassioris.

4. In distillationibus optime inquiritur et decernitur de gradibus et diversitatibus calorum; ut carbonum, furni calefacti, balnei, cinerum, arenæ calidæ, fimi, solis, ignis quiescentis, ignis follibus excitati, ignis conclusi et reverberati, caloris ascendentis, caloris descendentis, et hujusmodi; quæ omnia ad aperturas corporum, et præcipue ad complicatas actiones dilatandi et contrahendi (de quibus postea dicemus) insigniter faciunt. Neque tamen ullo modo videntur calores illi imitatores caloris solis et cœlestium; cum nec satis lenes sint et temperati, nec satis lenti et continuati, nec satis refracti et modificati per corpora media, nec satis inæqualiter accedentes et recedentes. De quibus omnibus, sub titulo Calidi et Frigidi, et titulis aliis ad hoc propriis, diligenter inquiremus.

5. Distillationes et dilatationes per eas fiunt in clauso, ubi concluduntur simul corpus distillandum, et vapores qui ex eo emittuntur, et aër. Neque tamen in stillatoriis et alembicis communibus diligenter arcetur aër exterior; quin per rostrum stillatorii, per quod liquor effluit, ille subintrare aliquatenus possit. At in retortis, ubi majore vehementia caloris opus est, non datur aëri exteriori ingressus; sed os receptaculi ori vasis (ubi corpus imponitur) per lutationes ita continuatur, ut universus processus rarefactionis et restitutionis intus transigatur. Quod si corpus sit plenum spiritu vigoroso (ut vitriolum), opus est receptaculo vasto et amplo, ut vapores liberius ludant, nec vas infringant.

Mandata. 1. Utcunque tamen distillationes tanquam intra cellam undiquaque clausam transigantur; datur tamen spatium, ut corporis aliæ partes se expandere in vapores, aliæ subsidere in fæcibus, vapores rursus se glomerare et restituere, atque (si heterogenei fuerint) alii ab aliis se separare possint. Quod sequitur igitur, pro mandato magno habendum; cum ad naturam in imis concutiendam et ad novas transformationes aditum præbere possit. Vulcanus enim chymicorum et medicorum (licet multa utilia genuerit) tamen virtutes veriores caloris fortassis minus complexus est, ob divortia et separationes partium quæ in operationibus ipsorum semper interveniunt. Itaque summa rei quam mandamus huc spectat; ut illa separatio et reciprocatio rarefactionis et condensationis omnino prohibeatur, atque opus caloris intra corpus ipsum atque ejus claustra vertatur: hoc enim fortasse Proteum Materiæ per manicas constrictum tenebit, et se versiones suas experiri et expedire compellet. De hoc complura nobis in mentem veniunt, et alia reperiri possunt. Proponemus exemplum unum aut alterum ex facillimis, ad hoc tantum, ut percipi possit quid velimus.

2. Accipe vas quadratum ferri, in figura cubi, habeatque latera bene fortia et crassa. Impone cubum ligni ad mensuram vasis ad amussim factum, quique illud prorsus impleat. Superponatur operculum ferri non minus forte quam latera vasis; et lutetur optime, more chymicorum, ita ut sit clausissimum, et ignem tolerare possit. Deinde ponatur vas intra prunas, atque ita permittatur ad horas aliquas. Post amoveatur operculum; et vide quid factum sit de ligno. Nobis

quidem videtur (cum prohibita plane fuerint inflammatio et fumus, quo minus pneumaticum et humidum ligni emitti potuerint) alterum ex his eventurum; vel ut corpus ligni vertatur in quoddam amalagma; vel ut solvatur in aërem, sive pneumaticum purum, simul cum fæcibus (magis crassis quam sunt cineres) in fundo, et incrustatione nonnulla in lateribus vasis.

3. In simili vase ferreo fiat experimentum de aqua pura; qua repleatur ad summum. Sed adhibeatur ignis lenior: mora vero sit amplior. Quinetiam amoveatur ab igne certis horis, et refrigescat; dein iteretur operatio aliquoties. Hoc experimentum de aqua pura delegimus hanc ob causam; quod aqua corpus simplicissimum sit, expers coloris, odoris, saporis, et aliarum qualitatum. Quamobrem si per calorem temperatum et lenem, et alternationem calefactionis et refrigerationis, et prohibitionem omnis evaporationis, spiritus aquæ non emissus, et nihilominus per hujusmodi calorem sollicitatus et attenuatus, se verterit in partes aquæ crassiores, easque ita digerere et in novum schematismum mutare possit (minus scilicet simplicem et magis inæqualem) eo usque, ut vel colorem alium nanciscatur, vel odorem, vel saporem, vel oleositatem quandam, vel aliam alterationem notabilem (qualis invenitur in corporibus compositis); proculdubio res magna confecta foret, et ad plurima aditum patefaciens.

4. Circa distillationem clausam (ita enim eam appellare licet, ubi non datur spatium ad evaporationem) quivis multa alia poterit comminisci. Pro certo enim habemus, calorem analogum, operantem in corpus absque separatione aut consumptione partium, mirabiles metaschematismos effingere et producere posse.

5. Attamen illud addi possit, ut mandati hujus appendix; ut excogitetur etiam aliquis modus (quod certe difficile non est) per quem calor operetur non solum in clauso, sed in tensili: id quod fit in omni matrice naturali, sive vegetabilium, sive animalium. Hoc enim operationem ad multa extendit, quæ per clausuram simplicem effici non possunt. Neque hoc pertinet ad Pygmæum Paracelsi[1], aut hujusmodi prodigiosas ineptias: sed ad solida et sana. Exempli gratia; non efficiet

[1] The Pygmæi of Paracelsus are the same as the gnomes or earth spirits. See his *Philosophical Works*, ii. p. 487. But perhaps for "pygmæum" we ought to read "archæum."

unquam distillatio clausa, ut aqua tota vertatur in oleum; quia oleum et pinguia majus occupant dimensum quam aqua. At si operatio fiat in tensili, hoc fortasse fieri possit: quæ esset res immensæ utilitatis, cum omnis alimentatio maxime consistat in pingui.

6. Bonum esset, et ad multa utile, ut in distillationibus natura ad rationes reddendas quandoque compelleretur; atque ut poneretur in certo quantum per distillationem consumptum fuerit, id est, versum in pneumaticum; et quid maneret, sive fixum, sive restitutum in corpore. Id fieri potest, si ante distillationem corpus distillandum ponderes, et vasa ipsa intra quæ distillatio perficitur. At post distillationem ponderabis liquorem; ponderabis item fæces; denique ponderabis iterum vasa. Ex istis enim tribus ponderationibus cognosces quantum fuerit restitutum, quantum manserit in fæcibus, quantum adhæserit vasibus; atque a decessione ponderis in illis tribus, comparati ad pondus corporis integri, cognosces quantum versum fuerit in pneumaticum.

Connexio.

TRANSEUNDUM a dilatationibus et rarefactionibus quæ fiunt per calorem actualem, ad dilatationes et relaxationes quæ fiunt per remissionem frigoris vehementis et intensi; quæ ipsa remissio censeri debet pro calore comparato.

Historia.

DILATATIONES ET RELAXATIONES CORPORUM PER REMISSIONEM FRIGORIS.

1. Quæ per frigus vehemens concreverunt, neque tamen eo usque ut per moram frigoris in densatione sua fixa sint, ea absque calore manifesto, et per remissionem tantum frigoris, se aperiunt et restituunt; ut fit in glacie, grandine, nive: sed hoc faciunt per calorem manifestum admotum multo celerius.

2. Verum delicatiora, quorum vigor consistit in spiritu nativo subtili, ut poma, pyra, granata, et similia, si semel fuerint congelata, suffocato spiritu, non recipiunt postea pristinum vigorem.

3. At vinum et cervisia per gelu ad gustum languescunt, nec vigent; attamen succedentibus regelationibus et tempestatibus australibus, reviviscunt et relaxantur, et quasi denuo fervescunt.

Connexio.

TRANSEUNDUM a dilatationibus quæ fiunt per calorem externum actualem, atque etiam per remissionem frigoris (quæ, ut jam diximus, est calor comparatus), ad dilatationes corporum quæ fiunt per calores potentiales, sive spiritus auxiliares alterius corporis applicati et admoti.

[*Historia.*]

DILATATIONES CORPORUM, QUÆ FIUNT PER CALOREM POTENTIALEM, SIVE PER SPIRITUS AUXILIARES ALTERIUS CORPORIS.

De caloribus potentialibus consule Tabulas Medicinales qualitatum secundarum; et ex his poteris excerpere ea quæ operantur super corpus humanum per dilatationem: quæ sunt fere illa quæ sequuntur.

Confortantia, quæ dilatant spiritus oppressos.
Abstergentia, quæ roborant virtutem expulsivam.
Aperientia, quoad orificia venarum et vasorum.
Aperientia, quoad poros et meatus partium.
Digerentia cum maturatione.
Digerentia cum discussione.
Caustica.

Hæc præcipue (sunt et alia) habent radicem in dilatatione spirituum et humorum et succorum et substantiæ, in corpore, per spiritus auxiliares; necnon per complexionem tangibilem, quæ inest medicinis illis, vel interius vel exterius sumptis.

Commentatio.

Patet in vitro calendari, quam exquisito sensu sive perceptione præditus sit aër communis calidi et frigidi: utpote quæ tam subtiles ejus differentias et gradus statim dijudicare possit. Nec dubito, quin perceptio spiritus in animalibus vivis versus calorem et frigus sit adhuc longe acutior: nisi quod aër sit pneumaticum purum et sincerum, et nihil habeat tangibilis admisti; at spirituum perceptio retundatur et hebetetur corpore tangibili in quo sunt devincti. Attamen, non obstante hoc impedimento, videntur adhuc spiritus vivorum potiores ipso aëre, quoad hanc perceptionem. Neque enim hactenus nobis constat, quod calor potentialis (de quo jam loquimur) aërem possit dilatare; cum certum sit, quod

hoc faciat super spiritus in animalium membris contentos; ut in qualitatibus (quas diximus) secundis medicinarum liquet. Sed de hoc inquiratur paulo accuratius, ex mandato proxime sequente.

Mandata. 1. Accipe duo vitra calendaria ejusdem magnitudinis. Impone in altero aquam, in altero spiritum vini, fortem et acrem; atque ita calefiant vitra, ut aqua et spiritus vini ad parem altitudinem ascendant. Colloca ea simul, et dimitte per spatium aliquod; et nota, si aqua deveniat altior quam spiritus vini. Nam si hoc fit, palam est, calorem spiritus vini potentialem aërem dilatasse, ita ut spiritum vini depresserit.

2. Possit esse res varii usus, si operationes secundarum qualitatum medicinalium probentur interdum, et exerceantur in corporibus vitæ expertibus. Licet enim dubium non sit, plerasque earum nullius prorsus effectus fore, quoniam requiritur plane spiritus vivus ad eas actuandas, ob operationis subtilitatem; aliæ tamen proculdubio super nonnulla corpora inanimata operabuntur. Videmus enim quid possit sal in carnibus, aromata in cadaveribus, coagulum in lacte, fermentum in pane, et hujusmodi. Inserviet igitur diligentia medicorum circa qualitates secundas, ad instruendas complures alias operationes, si animum advertas cum judicio; id semper supponens, quod virtus fortior requiritur ad operandum super corpus mortuum, quam vivum.

Connexio.

TRANSEUNDUM ad dilatationes corporum quæ fiunt per liberationem spirituum, refractis nimirum ergastulis partium crassiorum, quæ illos arcte detinuerant, ut se dilatare non possent. In corporibus enim quæ habent arctam compagem atque naturæ integralis nexibus fortiter devincta sunt, non exequuntur spiritus opus suum dilatationis, nisi fiat prius solutio continui in partibus crassioribus; vel per liquores fortes erodentes et stimulantes tantum, vel per eosdem cum calore. Atque hoc cernitur in aperturis et dissolutionibus metallorum, de quibus nunc (ut in reliquis) pauca proponemus.

Historia.

LATATIONES CORPORUM PER LIBERATIONEM SPIRITUUM SUORUM.

1. Accipe pondus auri puri ad denarium 1, in parvas bracteolas redacti, quæ etiam manu lacerari possint.

2. Accipe etiam pondus 4 den. aquæ regis; et mittantur simul in vitrum. Tum ponatur vitrum super foculum, in quo sit ignis prunarum modicus et lenis. Paulo post insurgunt arenulæ quædam, aut grana; quæ deinde post parvam moram se diffundunt et incorporantur cum aqua; ut aqua efficiatur, aqua tanquam electrica, et splendida, et veluti croco tincta. Dissolutio autem auri per aquam in quantitatibus prædictis fit tantum ad tertias. Neque enim aqua oneratur ulterius; adeo ut, si dissolvere cupis totum pondus illud auri den. 1, opus sit effundere portionem in qua solutio facta est, et superinfundere de novo pondus simile 4 den. aquæ regis, et sic tertio. Ista dissolutio fit leniter et placide modico igne, absque fumis, et sine calefactione vitri, alia quam per ignem.

3. Accipe argenti vivi in corpore pondus ad placitum, duplum aquæ fortis: ponito simul in vitro, neque ea ad ignem omnino admove. Attamen paulo post insurget intra corpus aquæ instar pulveris tenuissimi, et intra spatium horæ, absque igne, absque fumis, absque tumultu, vertetur corpus commistum in aquam bene claram.

4. Accipe plumbum in lamellis ad pond. den. 1, aquæ fortis ad pond. den. 9. Non fit bona incorporatio, ut in aliis metallis; sed aqua demittit majorem partem plumbi in calce ad fundum vitri, manente aqua perturbata, sed vergente ad diaphanum.

5. Accipe argenti in lamellis, sive bracteolis, pondus den. 1, aquæ fortis pond. den. 4; pone super foculum in vitro, cum igne lento. Insurgit argentum in arenis, aut bullulis, intra corpus aquæ, majoribus paulo quam aurum; deinde incorporatur cum aqua, et vertuntur simul in liquorem tenuem, sed album et quasi lacteum. Sed postquam paulisper resederit liquor et refrixerit, ejaculantur (sive hoc emanet ex metallo, sive ex aqua, sive ex utroque) fragmina glacialia intra corpus aquæ: postquam autem per moram longiorem penitus resederit, clarificat se liquor, et devenit clarus et crystallinus, demissa glacie in fundum. Sustinet aqua onerationem, qualem in auro,

et fit dissolutio simili fere calore, nec colligit calorem per motum magis quam aurum.

6. Accipe cuprum in bracteolis ad pondus den. 1, aquæ fortis ad pondus den. 6. Mitte super foculum. Insurget cuprum in bullulis sive arenulis majoribus adhuc quam argentum. Paulo post incorporatur cum aqua, et corpus commistum vertitur in liquorem cœruleum, turbidum; sed postquam resederit, clarificat se ætheris instar in cœruleum, pulchrum, et splendidum, demissis in fundum fæcibus instar pulveris, quæ tamen ipsæ per moram imminuuntur, et ascendunt, et incorporantur. At den. illi 6 aquæ fortis solvunt den. totum cupri, ut sustineat se onerari aqua duplo plus quam in auro et argento. Concipit autem dissolutio cupri calorem manifestum per tumultum interiorem, etiam antequam admoveatur ad ignem.

7. Accipe stannum in bracteolis ad pondus den. 1, aquæ fortis ad pond. den. 3; et vertitur totum metallum in corpus simile flori lactis aut coagulo; nec facile se clarificat; et concipit sine igne calorem manifestum.

8. Accipe ferri in laminis pond. den. 1, aquæ fortis pond den. 9; et sine igne surgit ferrum in magnis bullis, non tantum intra corpus aquæ, sed supra, adeo ut ebulliat extra os vitri, atque insuper emittat copiosum et densum fumum croceum; idque cum maximo tumultu, et calore vehementissimo, et qualem manus non sustineat.

Monitum. Dubium non est quin vires variæ aquarum fortium diversorum generum, et modi ignis sive caloris qui adhibetur, istas aperturas etiam variare possint.

Mandata. Qualis sit ista dilatatio metallorum per aperturas, videndum: utrum sit instar dilatationis auri foliati, quæ est pseudo-rarefactio (ut mox dicemus) quia corpus dilatatur potius loco quam substantia, qualis itidem est dilatatio pulverum; an revera corpus ipsum metallorum dilatetur in substantia. Hoc hujusmodi experimento probari potest. Pondera argentum vivum; excipe etiam modulum ejus in situla: pondera similiter aquam fortem, et excipe modulum ejus in altera situla: deinde dissolve et incorpora ea modo supradicto; postea pondera incorporatum, et immitte illud etiam in duas illas situlas, et nota, si pondus et mensura compositi ad pondus et mensuram simplicium juste respondeat. Delegimus autem argentum vivum ad experimentum, quia minor est suspicio alicujus consumptionis, cum fiat dissolutio sine igne.

Videndum (obiter) utrum dissolutio argenti vivi lapides ponderosissimos, aut fortasse stannum, sustineat, ut innatent. Etenim ex rationibus ponderum hoc colligi potest. Neque hoc pertinet ad miraculum et imposturam, sed ad investigandam naturam misturarum, ut suo titulo apparebit.

Observatio.

Notatu etiam dignum est (licet non sit præsentis inquisitionis) omnia metalla, licet sint aquis in quibus dissolvuntur insigniter graviora, tamen in actu primo dissolutionis ascendere in arenulis vel bullis. Atque eo magis hoc notandum est, quod ubi non admovetur ignis, ut in argento vivo, idem faciant.

Commentatio.

Tumultus intra partes corporis inter dissolvendum, istam ascensionem causat. Nam in vehementi erosione corpora impelluntur nonnihil motu locali; ut videre est in lapide parvo glareoso, qui positus in aceto forti ad latera patellæ (ut facilius labatur) per vices gliscit, ut pisciculus. Est et genus lapidis aut fossilis, quod immissum in acetum irrequiete se agitat, et huc illuc currit. At quæ sine impetu isto miscentur, (ut arbitror) nisi quassata, non ascendunt; velut saccharum in fundo aquæ non dulcificat in summo; nec crocus colorat, nisi moveatur et agitetur.

Connexio.

TRANSEUNDUM ad aliud genus dilatationum, quod etiam communi vocabulo *dissolutionum* (in aliquibus) nuncupatur. Fit autem ubi corpora versus alia corpora amica ruunt in amplexum; et, si datur copia, aperiunt se ut illa introcipiant. Neque fit hæc apertura tumultuose, aut per penetrationem corporis ingredientis, (ut in aquis fortibus), sed placide, et per relaxationem corporis recipientis.

Historia.

DILATATIONES PER AMPLEXUM ET OCCURSUM CORPORIS AMICI.

1. Saccharum et gummi nonnulla, ut tragacanthum, in liquoribus infusa, solvuntur; laxant enim libenter (instar spongiarum) partes suas ad recipiendum liquorem.

2. Papyrus, seta, lana, et hujusmodi porosa, liquoribus immersa, aut alias humectata, ita se aperiunt, ut deveniant magis mollia, lacerabilia, et quasi putria.

3. Gaudia subita, ut ob nuntium bonum, aspectus[1] ejus quod fuit in desiderio, et similia, licet non corpus amplectantur sed phantasiam aliquam, nihilominus spiritus animalium insigniter dilatant; idque interdum cum periculo repentini deliquii aut mortis. Simile facit imaginatio in venereis.

Mandatum. Cogitandum de inveniendis menstruis substantiarum specialium: videntur enim posse esse liquores et pulpæ, tantæ cum corporibus determinatis sympathiæ, ut, illis admotis, partes suas facile laxent, easque libenter imbibant; seque per hoc in succis suis intenerent et renovent. Hoc enim pertinet ad unum ex magnalibus naturæ; nempe, ut rerum humores maxime radicales refocillari et nutritio ab extra fieri possint, ut in carnibus, ossibus, membranis, lignis, &c. Etiam in iis quæ operantur per divulsionem et penetrationem, est sympathia sive conformitas: aqua fortis siquidem non solvit aurum, ut nec aqua regia communis argentum.

Connexio.

TRANSEUNDUM ad dilatationes per assimilationem aut versionem; quando scilicet corpus imperans et magis activum subigit corpus accommodum et obsequiosum et magis passivum, ita ut illud in se plane vertat, seque ex eo multiplicet et renovet. Quod si corpus assimilans sit tenuius et rarius quam corpus assimilatum, manifestum est assimilationem fieri non posse absque dilatatione.

Historia.

DILATATIONES QUÆ FIUNT PER ASSIMILATIONEM, SIVE VERSIONEM IN TENUIUS.

1. Aër, et maxime cum commotus est (ut in ventis), lambit humiditatem terræ, eamque deprædatur et in se vertit.

2. Processus desiccationis in lignis, herbis, et hujusmodi tangibilibus, non admodum duris aut obstinatis, fit per deprædationem aëris, qui spiritum in corpore evocat et exugit, et in se transubstantiat: itaque tarde hoc fit in oleosis et pinguibus,

[1] *Aspectum* in the original.—*J. S.*

quia spiritus et humidum ipsorum non sunt tam consubstantialia aëri.

3. Spiritus in tangibilibus (qualia diximus) deprædantur partes ipsas crassiores corporis in quo includuntur. Nam spiritus qui proximi sunt aëri, ipsi aëri obediunt, et exeunt cito: at qui in magis profundo corporis siti sunt, illi partes interiores adjacentes deprædantur, et novum inde spiritum gignunt et secum copulant, ut una tandem exeant: unde fit in istis corporibus per ætatem et moram diminutio ponderis; quod fieri non posset, nisi pars aliqua non pneumatica in pneumaticum sensim verteretur. Nam spiritus jam factus in corpore non ponderat, sed levat pondus potius.

4. Multi tumores in corporibus animalium discutiuntur absque suppuratione aut sanie, per insensilem transpirationem, versi plane in pneumaticum, et evolantes.

5. Esculenta flatuosa gignunt ventositates, succis suis versis in flatum, et exeunt per ructus et crepitus; etiam partes internas extendunt et torquent: quod faciunt etiam alimenta proba et laudata quandoque, ob debilitatem functionum.

6. In omni alimentato, cum pars alimentata tenuior est alimento (ut spiritus atque sanguis per arterias in animalibus leviores sunt quam cibus et potus), necesse est ut alimentatio inducat dilatationem.

7. Omnium aperturarum, dilatationum, et expansionum maxima, quatenus ad analogiam inter corpus ante dilatationem et post, omniumque pernicissima, et quæ minima mora et brevissimo actu transigitur, est dilatatio oleosorum et inflammabilium in flammam; quod fit quasi affatim et sine gradibus. Estque (quoad flammam successivam) plane ex genere assimilationum; multiplicante se flamma super fomitem suum.

8. At quod potentissimum in hoc genere est, non ad velocitatem primæ inflammationis (nam pulvis pyrius non tam cito inflammatur quam sulphur aut caphura aut naphtha), sed ad successionem flammæ semel conceptæ et ad superandum ea quæ resistunt, est commistio illa expansionum in aërem simul et in flammam (de qua supra diximus), quæ invenitur in pulvere pyrio (ut liquet in bombardis et cuniculis).

9. Notant autem chymistæ, etiam argenti vivi expansionem per ignem esse admodum violentam; quin et aurum, vexatum et occlusum, quandoque potenter erumpere, cum periculo operantium.

Connexio.

TRANSEUNDUM ad eas dilatationes, vel distractiones et divulsiones, quæ fiunt, non ab appetitu aliquo in corpore ipso quod dilatatur, sed per violentiam corporum externorum, quæ, cum suis motibus prævaleant, necessitatem imponunt corpori alicui ut dilatetur et distrahatur. Atque ista inquisitio pertinet ad titulum de Motu Libertatis; sed (ut in reliquis) aliquid de hoc, sed parce et paucis, jam inquiremus. Iste autem motus est plerunque geminus: primo, motus distractionis a vi externa; deinde motus contractionis vel restitutionis a motu corporis proprio: qui posterior motus licet ad condensationes spectet, tamen ita conjunctus est cum priore ut hic commodius tractari debeat.

[*Historia.*]

DILATATIONES SIVE DISTRACTIONES A VIOLENTIA EXTERNA.

1. Bacula lignea et similia flexionem nonnullam patiuntur, sed per vim; illa autem vis distrahit partes exteriores ligni in loco ubi arcuatur, et comprimit partes interiores: quod si vis illa paulo post remittatur, restituit se baculum, et resilit; sed si diutius in ea positura detineatur, figitur in ea, nec resilit amplius.

2. Similis est ratio horologiorum (eorum scilicet quæ moventur per torturam laminarum), in quibus videre est continuum et graduatum nixum laminarum ad se restituendum.

3. Pannus, et similia filacea, extenduntur majorem in modum, et resiliunt citius dimissa; non resiliunt longius detenta.

4. Caro quæ surgit in ventosis, non est tumor, sed violenta extensio carnis integralis per attractionem.

5. Qualem rarefactionem tolleret aër (pro modo scilicet violentiæ) tali experimento elicere possis. Accipe ovum vitreum, in quo sit foramen minutum: exuge aërem anhelitu quantum potes; deinde affatim obtura foramen digito, et merge ovum in aquam ita obturatum. Post tolle digitum, et videbis ovum attrahere aquam, tantum scilicet quantum exuctum fuerit aëris; ut aër qui remansit possit recuperare exporrectionem suam veterem, a qua fuerat vi distractus et extensus. Memini autem intrasse aquam, quasi ad decimam partem contenti ovi. Etiam memini me reliquisse ovum (post exuctionem)

cera obturatum per diem integrum, ut experirer, si per moram illam (quæ certe nimis brevis erat ad experimentum justum) aër dilatatus figi posset, nec curaret de restitutione, ut fit in baculis et pannis. Sed cum tolleretur cera, aqua intrabat ut prius; etiam si ovum appositum fuisset ad aurem, aër novus intrarat cum sibilo.[1]

6. At qualem rarefactionem aqua sustineat, possit forte hoc modo deprehendi. Accipe folles: attrahe aquam, quantum impleat cavum follium: neque tamen eleva folles ad summum, sed quasi ad dimidium. Deinde obstrue folles, et nihilominus eleva eos paulatim; et videbis, quatenus ista aqua recepta se dilatari patiatur. Aut etiam per fistulam, aut syringam, attrahe nonnihil aquæ; deinde foramen obtura, et embolum adhuc paulatim attrahe.

Commentatio.

Suspicor etiam fieri distractionem spiritus aquæ in conglaciatione; sed subtilis est hujus rei ratio. Primo, pro certo poni possit, in omni excoctione (puta luti, cum fiunt lateres et tegulæ, crustæ panis, et similium) multum ex pneumatico corporis exhalare et evolare (ut paulo post monstrabimus), atque inde necessario sequi, ut partes crassiores per motum nexus magna ex parte (nam est et alius motus, de quo nunc sermo non est) se contrahant. Nam sublato spiritu nec alio corpore facile subintrante, *ne detur vacuum* (ut loquuntur), in locum illum quem occupabant spiritus succedunt partes; unde fit illa durities et contractio. Eadem prorsus ratione, sed modo contrario, videtur necessario sequi, ut spiritus in conglaciatione distrahantur. Etenim partes crassiores per frigus contrahuntur; itaque relinquitur aliquod spatium (intra claustra corporis) occupandum; unde sequitur si aliud corpus non succedat, ut spiritus præinexistens per motum nexus distrahatur tantum, quantum partes crassiores contrahantur. Sane id conspicitur in glacie, quod corpus interius reddatur rimosum, crustulatum, et parum tumescat: quodque ipsa glacies, non obstante insigni partium contractione, sit (in toto) levior quam ipsa aqua: idque dilatationi pneumatici merito attribui possit.

[1] Compare Nov. Org. ii. 45.

Connexio.

TRANSEUNDUM ad dilatationes per deacervationem; quando, scilicet, quod erat cumulatum et acervatum, fit applanatum. Istæ autem dilatationes pro pseudo-dilatationibus habendæ sunt; dilatatio enim fit in positura partium, non in substantia corporis. Siquidem corpus manet in eadem densitate substantiæ; sed figuram nanciscitur ampliorem in superficie, minorem in profunditate.

[*Historia.*]

DILATATIONES PER DEACERVATIONEM.

1. Aurum per malleationem in immensum dilatatur, ut in auro foliato; item per distractionem, ut in argenteis filis inauratis: inauratio enim fit in massa antequam distrahatur.

2. Argentum etiam fit foliatum, licet non ad tam exquisitam tenuitatem quam aurum. Reliqua quoque metalla per malleationem dilatantur in bracteolas et lamellas tenues.

3. Cera, et hujusmodi, premuntur et finguntur in oblinimenta tenuia.

4. Gutta atramenti in calamo dilatatur ad exarationem multarum literarum: quod et fit per penicillum in pigmentis, et vernice.

5. Crocus in parva quantitate magnam inficit quantitatem aquæ.

Connexio.

ATQUE de dilatationibus, et rarefactionibus, et aperturis corporum, hæc inquisita sunto. Superest jam ut de contrariis actionibus simili diligentia inquiramus; id est, de contractionibus, et condensationibus, et clausuris corporum. Quam partem visum est seorsum tractare, eo magis quod non omnes actiones ex hac parte sint reciprocæ; sed nonnullæ earum propriæ, et per se explicandæ. Etiam, quamvis contraria ratione consentiant, tamen in experimentis valde diversis investigantur et se conspicienda præbent.

Actioni dilatationis per introceptionem corporis alieni, reciproca est actio contractionis per emissionem aut expressionem corporis alieni: itaque de eo primo est inquirendum.

[*Historia.*]

CONTRACTIONES PER EMISSIONEM AUT DEPOSITIONEM CORPORIS INTROCEPTI.

1. Consule instantias de dilatationibus per introceptionem, et oppone illis easdem instantias postquam dilatationes resederint: in his intelligimus, ubi datur residere.

2. Metalla pura et perfecta, licet variis modis vexentur et alterentur, ut in sublimationibus, præcipitationibus, malagmatibus, dissolutionibus, calcinationibus, et hujusmodi; tamen (natura metallica cum aliis corporibus non bene conveniente) per ignem et conflationem plerunque restituuntur, et vertuntur in corpus quale prius. Est autem condensatio ista minus vera, quia videtur esse nihil aliud quam emissio et exclusio aëris qui se miscuerat, aut aquarum in quibus dissoluta erant, ad hoc, ut partes genuinæ corporis metalli rursus coire possint. Neque tamen dubium est, quin corpus longe minus spatium occupet quam prius, sed minime videtur densari substantia. Atque hæc *potestas clavium*, quæ aperit et claudit, viget maxime in metallis. Etiam metalla impura, et marcasitæ, atque mineræ metallorum, eodem modo (per ignem congregatis partibus homogeneis, et emissa et exclusa scoria et purgamentis) depurantur. Etenim omne metallum purum densius est et ponderosius impuro.

3. Ad magis arctam autem condensationem metallorum facit, si metalla sæpius fusa, sæpius in aquis extincta sint; unde magis obstinata fiunt, et indurescunt. Utrum vero pondere ipso augeantur, pro ratione dimensi, hactenus non constat. De eo fiat experimentum. Atque ista induratio magis adhuc potenter fit per crebras solutiones et restitutiones, quam per fusiones et extinctiones. Inquirendum etiam est, in quali genere aut mixtura aquarum indurescant magis.

4. Reperiuntur tamen modi mortificationum metallorum, id est, prohibitionum ne cum soluta et aperta fuerint restituantur. Id maxime cernitur in argento vivo; quod, si strenue tundatur, et inter tundendum injiciatur parum terebinthinæ, aut salivæ hominis, aut butyri, mortificatur argentum vivum, et nanciscitur aversationem et fastidium ad se restituendum.

Mandatum. Diligenter inquirendum de mortificationibus, hoc est, de impedimentis restitutionum omnium metallorum. Magna enim debet esse antipathia eorum quæ prohibent ne

ea coeant. Cumque omnis restitutio ipsorum sit genus quoddam condensationis, pertinebit scilicet cognitio privationis ad cognitionem formæ.

Historia.[1]

1. DILATATIONIBUS per spiritum innatum se expandentem non opponitur proprie actio aliqua reciproca: cum contractio res aliena sit a spiritu, qui non contrahitur, nisi cum aut suffocatur, aut patitur, aut colligit se (arietis instar) ut fortius se dilatet. Attamen commode hoc loco substituemus actionem illam quæ est propria partium crassiorum, sed per accidens imputari debet spiritui innato; ea est, ubi per evolationem sive emissionem spiritus, contrahuntur et indurantur partes. Spiritus autem emittitur vel ex agitatione sua propria, vel sollicitatus ab aëre ambiente, vel provocatus et irritatus ab igne seu calore.

Commentatio.

Idem faciunt quoad attenuationem et emissionem spiritus, et actiones quæ ex ea sequuntur, ignis sive calor, et tempus sive ætas. Verum ætas per se curriculum est solummodo aut mensura motus. Igitur cum de ætate loquimur, intelligimus de virtute et operatione composita ex agitatione spiritus innati, et aëre ambiente, atque radiis cœlestium. Sed illud interest, quod ignis et calor vehemens dilatet corpora confertim, et fortiter, et visibiliter; ætas autem, instar caloris lenissimi, paulatim, et leniter, et occulto: fumi enim et vapores scilicet spissi sunt et conspicui, perspirationes vero neutiquam; ut manifestum est in odoribus. Attamen magis subtilis et exquisita est ea corporum attenuatio et rarefactio quæ fit per ætatem, quam quæ fit per ignem.[2] Nam ignis præcipitans actionem, pneumaticum quod in corpore est rapide evolare facit; humidum quoque quod præparatum est

[1] Though this paragraph is headed *Historia* in the original, and numbered 1., and printed in the smaller type, it corresponds to that class of paragraphs which are in other places distinguished by the title *Connexio*. I have therefore divided it from what goes before by the same marks which I have used elsewhere to denote the transition to a new article of inquiry, and printed it in the larger type; and though I have not ventured otherwise to alter the text, I have no doubt that for *Historia*, *Connexio* ought to be substituted. — *J. S.*

[2] Compare Nov. Org. ii. 20.

in pneumaticum subinde vertit, atque tale factum emittit: unde partes tangibiles sedulo se interim et gnaviter constipant, et non parum spiritus (tanquam manu injecta) morantur et detinent. At ætas pneumaticum jam factum ad evolationem non urget subito; unde fit ut illud diutius manens in corpore, quicquid in tenue digeri possit sensim et seriatim præparet, parum ex pneumatico jam facto placide et successive interim evolante; adeo ut anticipet fere et tanquam fallat constipationem partium tangibilium. Quamobrem in dissolutione per ætatem, sub finem negotii, parum admodum tangibilis figitur et manet. Etenim pulvis ille putris, qui per longos annorum circuitus manet, tanquam consumptionis reliquiæ, (qualis in sepulchris et monumentis vetustis nonnunquam invenitur), res quasi nihili est, et omni incineratione quæ fit per ignem minutior, et magis destitutus. Nam cineres etiam succum habent, qui possit elici et verti in sales: hujusmodi pulvis minime. Verum, quod ad inquisitionem præsentem pertinet, et cujus causa hæc dicta sunt, certum est spiritum, quamdiu detinetur in corpore, partes tangibiles colliquare, intenerare, conficere, subruere; verum ab ejus emissione partes tangibiles continuo se contrahere et constipare.

Historia.

CONTRACTIONES PER ANGUSTATIONEM PARTIUM CRASSIORUM POST SPIRITUM EMISSUM.

1. In senectute cutes animalium corrugantur, et membra arescunt.

2. Pyra et poma diu servata rugas colligunt; nuces autem ita contrahuntur, ut non impleant testam.

3. Casei veteres in cortice exteriore efficiuntur rugosi. Ligna in trabibus, postibus, et palis, tractu temporis (præsertim si ponantur viridia) contrahuntur in arctum, ut disjungantur et hient. Simile fit in globis lusoriis.

4. Terra in magnis siccitatibus divellitur, et in superficie sua plena rimarum efficitur: etiam quandoque rimæ tam in profundum penetrant, ut ad eruptionem aquarum causam præbeant.

Monitum. Nemo nugetur, aiens istam contractionem in desiccationibus nihil aliud esse, quam absumptionem humidi

Nam si id tantum ageretur ut humidum in spiritum versum evolaret, deberent corpora manere in priore exporrectione et dimenso suo, et solummodo cava fieri, ut pumices aut suber; non autem localiter contrahi et minui dimenso suo.

5.[1] Lutum per fornaces cogitur in lateres et tegulas: at si instet calor vehemens, ut in medio fornacis, vertitur etiam nonnulla pars luti et funditur in vitrum.

6. Ligna, si suffocetur flamma, vertuntur in carbones; materiam scilicet magis spongiosam et levem quam ligna cruda.

7. Metalla pleraque sepulta in crucibulis inter prunas ardentes, et multo magis per fornaces reverberatorias, vertuntur in materiam friabilem, et calcinantur.

8. Complura fossilia et metalla, et ex vegetabilibus nonnulla, vitrificantur per ignes fortes.

9. Omnia quæ assantur, si ignem plus æquo tolerent, incarbonantur, et recipiunt se in angustius dimensum.

10. Papyrus, membrana, lintea, pelles, et similia, per ignem non solum corrugantur in partibus, sed etiam se complicant et convolvunt, et tanquam rotulantur in toto.

11. Lintea, a flamma primo concepta, paulo post suffocata, vertuntur in substantias raras, quæ vix inflammantur, sed facile ignescunt: quibus utimur ad fomites flammarum.

12. Pinguia, ut cera, butyrum, lardum, oleum, et similia, per ignem deveniunt frixa et fæculenta, et tanquam fuliginosa.

13. Ova contrahuntur ab igne, et quatenus ad albumen ipsorum, colorem mutant a claro in candidum.

14. Quinetiam si ovum testa exutum injiciatur in spiritum vini bonum et fortem, elixatur, et fit candidum; similiter et offa panis injecta in ipsum devenit quasi tosta.

Observationes.

1. Quamdiu (ut paulo ante innuimus) spiritus in corpore detinetur, si per ignem aut calorem excitatus et dilatatus fuerit, tamdiu agitat se, molitur exitum, partes tangibiles emollit, intenerat, colliquat: atque hoc est proprium opus spiritus, qui digerit et subigit partes. Sed postquam spiritus sibi exitum invenerit et emissus fuerit, tum prævalet opus partium, quæ a spiritu vexatæ conspirant, et se stringunt;

[1] The ten following paragraphs have in the original a fresh heading and a fresh series of numbers. I have again followed Mr. Montagu's example in continuing the series. — *J. S.*

tam ex desiderio nexus et mutui contactus, quam ex odio motus et vexationis. Atque inde sequitur coarctatio, induratio, obstinatio.

2. Est in processu contractionis partium ab igne, finis et ultimitas: nam si minor sit copia materiæ per violentam deprædationem ignis, quam ut cohærere possint; tum demum se deserunt, et incinerantur et calcinantur.

Connexio.

ATQUE de contractionibus quæ fiunt ab emissione spiritus e corporibus, sive is emittatur per ætatem sive per ignem sive per calorem potentialem, hæc inquisita sunto. Actioni vero dilatationis per calorem actualem externum reciproca est actio contractionis per frigus actuale externum. Atque hæc condensatio est omnium maxime propria et genuina; maxime potens etiam foret, nisi quod non habemus hic apud nos in superficie terræ frigus aliquod intensum. Frigus autem et caloris remissio (nam utrunque hoc loco conjungere visum est) alia simpliciter, manente natura sua, condensat; alia rarefacta (sed imperfecte) restituit; alia per condensationem plane vertit et transformat de natura in naturam. De his omnibus jam pauca sunt proponenda.

CONTRACTIONES CORPORUM PER FRIGUS ACTUALE EXTERNUM.

1.[1] Aër in vitro calendari percipit gradus tam frigidi quam calidi. Atque temporibus nivalibus super caput vitri quasi pileum ex nive posuimus; qui, licet aër ipse illo tempore fuisset hiemalis et asper, tamen frigus in tantum auxit, ut aqua per paucos gradus, aëre contracto, insurgeret.

2. Superius posuimus, aërem in vitro ad tertias per calorem dilatatum fuisse, atque tantundem, remittente calore, se contraxisse.

Mandata. 1. Experimento plane dignum est, ut probetur utrum aër per calorem dilatatus figi in eadem exporrectione possit, ut se restituere et contrahere non laboret. Itaque accipe vitrum calendare robustum, idemque vehementer calfacito;

[1] I am inclined to think that the *historia* upon the article properly begins here, and not after the *mandata*, as in the original. But as the process of inquiry is clear enough as it stands, I have not thought it necessary to make any alteration. — *J. S.*

deinde os bene obturato, ne aër se contrahere possit; et per aliquot dies obturatum dimittito: deinde in aquam ita obturatum mergito; et postquam in aqua fuerit, aperito, et videto quantum aquæ trahat, atque utrum sit ad eam proportionem quam alias tracturum fuisset si vitrum statim in aquam fuisset missum.

2. Etiam obiter nota (etsi ad titulum de Calido et Frigido potius pertineat) utrum aër, ita fortiter dilatatus et per vim detentus, retineat calorem suum multo diutius quam si os vitri apertum fuisset.

Historia.

1. Stellæ tempore hiemali, noctibus valde serenis et gelidis, apparent grandiores quam noctibus æstivis serenis: quod fit præcipue ex universali condensatione aëris, qui tum vergit magis ad naturam aquæ: nam sub aqua omnia apparent longe grandiora.

2. Rores matutini sunt proculdubio vapores, qui in aërem purum non erant plene dissipati et versi, sed hærebant imperfecte misti, donec per frigora noctis, præsertim in regione media quam vocant aëris, fuerint repercussi, et in aquam condensati.

3. Condensatio pluviæ et nivis et grandinis fit similiter per frigus mediæ regionis, quod vapores coagulat magis (ut plurimum) in alto, quam rores. Occurrunt vero dubitationes duæ, circa quas diligens fieri debet inquisitio. Altera, utrum guttæ ipsorum congelentur et condensentur in ipso casu; an fuerint illæ primo collectæ et congregatæ in moles majores aquarum, in aëre (propter distantiam a terra) pensiles, quæ postea, per violentiam aliquam conquassatæ, frangunt se et comminuunt in guttas; ut in nonnullis cataractis Indiæ Occidentalis, quæ tam subito et confertim descendunt, ut videantur quasi ex vasibus fusæ et dejectæ. Altera, utrum non solum vapores (qui olim fuerunt humores et aquæ, et solummodo restituuntur), sed etiam pars magna aëris puri et perfecti, per frigus (in illis regionibus vehemens et intensum) non fuerit coagulata, et mutata plane, et versa in pluviam, et reliqua; de quo paulo post inquiremus.

4. In distillationibus, humores primo vertuntur in vapores; illi, per remotionem ab igne destituti, per latera stillatorii con-

trusi, et nonnunquam per frigidam ab extra infusam accelerati, restituunt se in aquas et liquores. Imago prorsus familiaris rorum et pluviæ.

5. Argentum vivum præcipue, necnon metallica alia, cum volatilia facta fuerint, properant tamen ad se restituendum, et occursu alicujus solidi et materiati magnopere gaudent. Itaque facile hærent, facile decidunt; adeo ut quandoque sit necesse vapores ipsorum igne persequi, et de igne in ignem transmittere, factis tanquam scalis receptaculorum ignis, ad nonnullam distantiam inter se, circa vas; ne vapor, postquam per ascensionem paulo fuerit remotior ab igne, citius quam expedit se restituat.

6. Quæ ab igne colliquata fuerint, post remissionem caloris densantur et consistunt ut prius; ut metalla, cera, adeps, gummi, &c.

7. Vellus laneum, super terram diutius jacens, colligit pondus; quod fieri non posset, nisi aliquid pneumaticum densaretur in ponderosum.

8. Solebant antiquitus nautæ, velleribus lanæ, tanquam tapetibus aut aulæis, vestire latera navium noctu, ita ut non attingerent aquam; atque inde mane exprimere aquam dulcem, ad usum navigantium.[1]

9. Etiam expertus sum de industria, quod alligando quatuor uncias lanæ ad funem, qui demittebatur in puteum 28 orgyarum, ita tamen ut aquam per sex orgyas non attingeret, ex mora unius noctis crevisset pondus lanæ ad quinque uncias et drachmam unam; et hæsissent per exterius lanæ plane guttæ aquæ, ut ex iis tanquam lavare aut madefacere manus quis possit: idque iterum atque iterum expertus sum, variante quantitate ponderis, sed semper multum aucta.

10. Lapides, ut marmora et silices, atque etiam trabes ligneæ (præsertim pictæ et oblitæ oleo), manifesto madefiunt sub regelationibus aut tempestatibus australibus; ut tanquam exudare videantur, et guttæ inde detergi possint.

11. In gelu madido (quod Anglice *Rynes* vocant) fit irroratio in ædibus super vitra fenestrarum; idque magis interius versus cubiculum, quam exterius ad aërem apertum.

12. Anhelitus, qui est aër primo attractus ac deinde intra

[1] Pliny, xxxi. 37. The same thing is mentioned in the *Sylva Sylvarum* (76.), as also the experiment detailed in the next paragraph.

cavum pulmonum brevi mora parum humefactus, super specula aut corpora polita (qualia sunt gemmæ, laminæ ensium, et similia) vertitur in quiddam roscidum, quod paulo post instar nubeculæ dissipatur.

13. Lintea, etiam in ædibus (ubi ignis non accenditur), colligunt humiditatem, ita ut foco appropinquata fument.

14. Pulveres omnes in repositoriis conclusi colligunt humiditatem, ut hæreant et quasi glebefiant.

15. Existimatur origo fontium et aquarum dulcium, quæ ex terra scaturiunt, fieri ex aëre concluso in cavis terræ (præsertim montium) coagulato et condensato.

16. Nebulæ sunt condensationes aëris imperfectæ, commistæ ex longe majore parte aëris et parum aquei vaporis; et fiunt, hieme quidem, sub mutatione tempestatis a gelu ad regelationem, aut e contra; æstate vero et vere, ex expansione roris.

Mandatum. 1. Quia versio aëris in aquam utilissima res esset, idcirco omnes instantiæ quæ ad hoc innuunt diligenter pensitandæ: atque inter alia in certo ponendum, utrum exudationes marmorum, et similium, in tempestatibus australibus et pluviosis sint meræ condensationes aëris a duritie et lævore lapidum repercussi, instar anhelitus in speculo; an participent nonnihil ex succo et pneumatico intrinseco lapidis.

2. Probatio fieri possit per pannum lineum aut lanam supra lapidem positam: nam si tunc quoque exudat lapis, participat exudatio ex causa interiore.

Commentatio.

Quod ipse aër vertatur in aquam in regionibus supernis, omnino necessario concluditur ex conservatione rerum. Nam certissimum est humores maris et terræ verti in aërem purum, postquam vaporum naturam, tempore et consortio et rarefactione plenaria, penitus exuerint. Itaque si non esset reciprocatio, ut aër vicissim quandoque verteretur in aquam, quemadmodum aqua vertitur in aërem, non sufficerent plane vapores, qui remanent novelli et imperfecte misti, ad pluvias et imbres et re-integrationes specierum; sed secutæ forent siccitates intolerabiles, et conflagratio, et venti impetuosi, et tumores aëris, ex aëre perpetuo multiplicato.

17.[1] In conglaciatione aquæ, moles corporis integri non decrescit, sed intumescit potius. Fit tamen manifesta densatio in partibus; adeo ut conspiciantur rimæ et divulsiones intra corpus glaciei. Etiam quandoque (si aër subintret) cernuntur sensim capillitia et fila et flosculi. Glacies autem innatat aquæ; ut manifestum sit, non fieri densationem integralem.

18. Vinum tardius congelascit quam aqua; spiritus vini non omnino.

19. Aquæ fortes et argentum vivum (arbitror) non gelascunt.

20. Oleum et adeps gelascunt et densantur, sed non ad indurationem.

21.[2] Gelu terram facit concrescere, eamque reddit siccam et duram.

22 Poëta ait de regionibus hyperboreis:

Æraque dissiliunt vulgo, vestesque rigescunt.[3]

23. Id quod faciunt tabulæ ligneæ, præsertim in juncturis glutinatis.

24. Etiam clavi, per contractionem frigoris, decidunt (ut referunt) e parietibus.

25. Ossa animalium per gelu deveniunt magis crispa; adeo ut fractura ipsorum per hujusmodi tempora et facilius fiat, et ægrius curetur. Denique omnia dura redduntur per frigus magis fragilia.

26. Condensantur manifesto aquæ aut succi in lapides splendentes sive crystallinos; ut videre est in cavernis subterraneis intra rupes; ubi cernuntur stillæ multiformes (instar stillarum conglaciatarum) sed fixæ et saxeæ, pensiles, quæ in ipso decasu (lento scilicet et tardo) congelatæ fuerunt. Utrum vero materia ipsarum sit prorsus aqua, an succus nativus lapidis (saltem commistus) in dubio est; præsertim cum gemmæ et crystalla in rupibus apertis exurgant sæpe et excrescant (quod non potest imputari aquæ adhærenti) in sursum, et non decidant aut pendeant.

27. Lutum manifesto condensatur in lapides; ut videre est

[1] In the original the heading *Historia* is repeated here, and the series of numbers begins afresh. But as it is obviously a continuation of the inquiry upon the same article, I have continued the numbers; and the repetition of the heading is superfluous according to the typographical arrangement which I have adopted. — *J. S.*

[2] This paragraph is not numbered in the original. — *J. S.*

[3] Virgil, Georg. iii. 363.

in aliquibus lapidibus magnis compositis ex parvis calculis, qui materia lapidea satis polita, et æque dura ac ipsi calculi, in interstitiis calculorum conglutinantur. Sed videtur hæc condensatio fieri non solum ex frigore terræ, sed per assimilationem, de qua paulo post.

28. Sunt quædam aquæ, quæ lignum, etiam paleas (ut aiunt) et hujusmodi, condensant in materiam lapideam; adeo ut pars ligni adhuc integri, quæ fuerit sub aqua, sit saxea; quæ emineat, maneat lignea; quod etiam vidi. De eo diligentius inquirendum, cum multum lucis præbere possit ad operativam condensationis.[1]

Mandatum. Probabile est aquas metallicas, ob densitatem quam contraxerint a metallis, posse habere naturam insaxantem. Fiat probatio per stipulam, folia crassiora, lignum, et similia. Sed arbitror deligendas esse aquas metallicas quæ fiunt per ablutionem aut crebram extinctionem, potius quam per dissolutionem; ne forte aquæ illæ fortes et corrosivæ impediant condensationem.

29.[2] In China habent mineras porcellanæ artificiales, defodiendo (nonnullas orgyas subter terram) massam quandam cæmenti ad hoc præparati et proprii; quæ post quadraginta aut circiter annos sepulta vertitur in porcellanam; ita ut transmittant homines hujusmodi mineras de hærede in hæredem.[3]

30. Accepi rem fidei probatæ, de ovo quod diu jacuerat in fundo aquæ, quæ circuibat ædes; quod inventum versum erat manifesto in lapidem, manentibus coloribus et distinctionibus vitelli, albuminis, testæ; sed testa erat fracta hic illic, et splendescebat in crustulis.[4]

31. Audivi sæpius de versione albuminis ovi in materiam lapideam; sed nec veritatem rei nec modum novi.

32. Flamma proculdubio, cum extinguitur, vertitur in aliquid; videlicet in post-fumum; qui et ipse vertitur in fuliginem. De flammis vero spiritus vini, et hujusmodi aurarum, diligentior facienda est inquisitio, in quale corpus densentur, et qualis sit post-aura ipsarum. Neque enim apparet fuliginosum aliquod, ut in flammis ex oleosis.

[1] Compare Gilbert, Physiol. v. 22.
[2] The original repeats the heading (*historia*) here.
[3] This account seems to be taken from Marco Polo, ii. 77.
[4] Compare Sylv. Sylvar. 85.

Connexio.

ATQUE de contractionibus corporum per frigus actuale, sive hoc fiat in aëre, sive in aquis et liquoribus, sive in flamma; ac rursus, sive illa sit contractio simplex, sive restitutio, sive coagulatio et versio, hæc inquisita sint. Sequitur actio quæ opponitur dilatationi per calorem potentialem, scilicet contractio per frigus potentiale.

[*Historia.*][1]

CONTRACTIONES CORPORUM PER FRIGUS POTENTIALE.

1. Quemadmodum consulendæ sunt tabulæ medicinales qualitatum secundarum ad inquisitionem de calore potentiali, similiter consulendæ sunt ad inquisitionem de frigore potentiali: in quibus excerpi debent potissimum astrictio, repercussio, oppilatio, inspissatio, stupefactio.

2. Opium, hyoscyamus, cicuta, solanum, mandragora, et hujusmodi narcotica, spiritus animalium manifesto densant, in se vertunt, suffocant, et motu privant. Utrum vero super corpora mortua aliquid possint, fiat experimentum macerando carnes in succis ipsorum (ad experiendum si succedat denigratio et gangræna); vel macerando semina et nucleos (ad experiendum utrum mortificent ipsa, ut non crescant); vel linendo summitatem vitri calendaris per interius succis ipsorum, (ad experiendum utrum aliqualiter contrahant aërem).

3. Apud Indias Occidentales reperiuntur, etiam per deserta arenosa et valde arida, cannæ magnæ, quæ super singulas juncturas, sive genicula, bonam copiam præbent aquæ dulcis, magno commodo itinerantium.[2]

4. Referunt esse in quadam insula, aut ex Terceris aut ex Canariis, arborem quæ perpetuo stillet; imo quæ nubeculam quandam roscidam semper habeat impendentem.[3] Digna autem res cognitu esset, utrum inveniatur in vegetabili aliquo potentiale frigus, quod denset aërem in aquam. Itaque de hoc diligenter inquiratur. Sed magis existimo, has esse cannas geniculatas, de quibus diximus.

5. Inveniuntur super folia nonnullarum arborum (veluti

[1] Though the heading (*Historia*) is omitted here in the original, it is introduced between the *mandatum* and the paragraph numbered 7., and therefore must have been omitted here by oversight. — *J. S.*

[2] See Purchas's Pilgrims, v. p. 913.

[3] Ibid. iv. 1359. The island is Ferro.

quercus) quæ unita sunt, nec humorem sugunt aut condunt, præcipue mense Maii apud nos, rores dulces, instar mannæ, et quasi melliti: utrum vero sit vis aliqua in foliis coagulans, an tantum illa rores commode excipiant et custodiant, non constat.

6. Vix invenitur corpus, in quo emineat tantum potentiale frigus quantum in nitro. Nam ut aromata, et alia, (licet ad tactum minime) tamen ad linguam aut palatum habent calorem perceptibilem; ita etiam nitrum ad linguam vel palatum habet frigus perceptibile, magis quam sempervivum, aut aliqua herba ex maxime frigidis. Itaque videtur subjectum accommodum ad experiendum virtutem potentialis frigidi in nitro. Poterit autem esse mandatum tale:

Mandatum. Accipe minutam vesicam ex pellicula, quantum fieri potest, tenui. Infla et liga; et merge eam intra nitrum per aliquos dies, et exime; et nota, si vesica aliqualiter flaccescat: quod si facit, scias frigus nitri aërem contraxisse. Fiat idem experimentum mergendo vesicam intra argentum vivum. Sed debet suspendi vesica per filum, ut mergi possit, et minus opprimi.

7. Accipe unguentum rosarum, aut hujusmodi; infunde aceti nonnihil: tantum abest ut liquor aceti reddat unguentum magis liquidum, ut contra illud reddat magis induratum et solidum.

Connexio.

ACTIONI dilatationis per amplexum opponitur [actio] contractionis per fugam et antiperistasin. Quemadmodum enim corpora versus grata et amica se laxant undiquaque, atque eunt in occursum; ita cum incidunt in odiosa et inimica, fugiunt undiquaque, et se contrudunt et constringunt.

[*Historia.*]

CONTRACTIONES CORPORUM PER FUGAM ET ANTIPERISTASIN.

1. Calor ignis per antiperistasin videtur nonnihil densari, et fieri acrior, ut sub gelu.

2. Contra, in regionibus torridis, videtur densari frigus per antiperistasin; adeo ut, si quis se recipiat ex campo aperto et radiis solaribus sub arbore patula, statim cohorreat.

3. Attribuitur, nec prorsus male, ista operatio contractionis per antiperistasin mediæ regioni aëris, ubi colligit se et unit natura frigidi, fugiens radios solis directos sparsos a cœlo, et

reflexos resilientes a terra; unde fiunt magnæ condensationes in illis partibus pluviarum, nivis, grandinis, et aliorum.[1]

4. Merito dubitari possit, utrum opium et narcotica stupefaciant a potentiali frigido, vel a fuga spirituum. Nam videtur opium partes habere calidas, ex fortitudine odoris, ex amaritudine, et provocatione sudoris, et aliis signis. Verum cum emittat vaporem inimicum et horribilem spiritibus, fugat illos undiquaque; unde se coagulant, et suffocantur.

Connexio.

ACTIONI dilatationis quæ fit per assimilationem et versionem in tenuius, opponitur actio contractionis quæ fit per assimilationem et versionem in densius. Intelligimus autem, quando hoc fit non per frigidum, vel actuale vel potentiale, sed per imperium corporis magis activi, quod se multiplicat ex corpore magis passivo. Assimilatio autem ad densum magis rara est, et minus potens multo, quam assimilatio ad rarum; quia corpora densa magis sunt ignava et inertia ad opus assimilationis quam tenuia.

[*Historia.*]

CONTRACTIONES CORPORUM PER ASSIMILATIONEM, SIVE VERSIONEM IN DENSIUS.

1. Supra notavimus, lutum inter lapides parvos densari in materiam lapideam.

2. Latera doliorum densant fæces vini in tartarum.

3. Dentes densant ea quæ ex manducatione cibi et humoribus oris adhærent, in squamas, quæ purgari et abscindi possint; verum æque duras ac ipsum os dentium.

4. Omnia dura et solida aliquid ex liquoribus et in fundo (maxime) et per latera adhærentibus condensant.

5. Quæcunque alimenta vertuntur in corpus alimentatum magis densum quam corpus ipsius alimenti (sicut cibus et potus in animalibus vertuntur in ossa, calvariam, et cornua), in assimilando (ut manifestum est) condensantur.

Connexio.

ACTIONI dilatationis per violentiam externam, sive ex appetitu sive contra appetitum corporis dilatati, opponitur

[1] Arist. Meteor. i. 12.

actio contractionis per violentiam similiter externam; cum corpora ponuntur in necessitate, ab illis quæ in ipsum agunt, cedendi et se comprimendi.

[*Historia.*]

CONTRACTIONES CORPORUM, QUÆ FIUNT PER VIOLENTIAM EXTERNAM.

1. Aër per violentiam sive compressionem externam aliquam condensationem facile patitur; majorem vero non tolerat: ut in violento impetu ventorum et terræ-motibus liquet.

2. Accipe catinum ligneum, inverte concavum ejus, et dimitte in aquam perpendiculariter, et facito illum descendere, impellens manu. Portabit secum aërem usque in fundum vasis, nec recipiet aquam interius, nisi parum infra summa labra; id ex colore ligni madefacti apparebit. Tanta autem fuerat condensatio aut compressio aëris, non amplior. Hoc ipsum insigniter apparebat, invento instrumento ad usum operariorum sub aqua.[1] Illud tale erat. Deprimebatur dolium magnum et concavum aëre impletum. Illud stabat supra tres pedes metallicos, crassos, ut mergi posset. Pedes erant breviores statura hominis. Urinatores, cum respiratione iis opus esset, flectebant se, et inserebant capita ipsorum in dolium, et respirabant: et hoc repetebant, et opus continuabant ad moram nonnullam; quousque scilicet aër, qui per insertionem capitis semper in quantitate nonnulla e dolio exibat, ad minimum diminutus esset.

3. At quantum ipsum condensationis, quod libenter toleraturus sit aër, cognoscere et supputare possis hoc modo. Accipe pelvem aquæ plenam: mitte in eam globulum ex metallo, aut lapidem, qui resideat in fundo. Superimpone catinum, vel impellens manu, vel ex metallo ita fabricatum, ut fundum sponte petat. Si globulus fuerit talis magnitudinis, ut aër condensationem (qualis ad globulum intra catinum recipiendum sufficiat) libenter pati possit, condensabit se aër placide, et nullus erit alius motus: sin majoris fuerit magnitudinis, quam aër bene ferre possit, resistet aër, et levabit latus aliquod ipsius catini, et exibit in bullis.

4. Etiam ex compressione vesicæ videbis quousque comprimi possit sine ruptura; aut etiam ex follibus levatis, et denuo obturatis, (prius foraminibus compressis). De condensatione aquæ

[1] Compare Nov. Org. ii. 50.

tale a nobis factum est experimentum.[1] Globum fieri fecimus plumbeum, cum lateribus bene crassis, et foramine in summo non magno. Globum aqua replevimus, et foramen metallo (ut meminimus) optime solidavimus. Tum globum illum, tanquam ad duos polos contrarios, primo malleis, deinde per pressorium robustum, fortiter compressimus. Cum autem ea applanatio multum sustulisset ex capacitate globi, adeo ut ad octavam quasi diminuta fuisset, tamdiu et non amplius sustinuit se aqua condensari. Sed ulterius vexata et compressa non tolerabat, sed exibat aqua ex multis partibus solidi metalli, ad modum parvi imbris.

5. At omnis motus, quem vocant, violentus, veluti pilarum e tormentis, sagittarum, spiculorum, machinarum, et aliorum infinitorum, expeditur per compressionem præternaturalem corporum, et nixum ipsorum ad se restituendum; quod cum commode ad tempus facere non possint, loco moventur. Nam solida, præsertim dura, ulteriorem compressionem ægre admodum tolerant. Verum hujusce rei inquisitionem ad titulum de Motu Libertatis rejicimus. Etenim, ut sæpius diximus, titulus præsens de Denso et Raro spicas tantum legit, non demetit.

6. Quo corpora sunt rariora, eo ab initio se contrahunt facilius; quod si ultra terminos suos compressa fuerint, eo se vindicant potentius; ut in flamma et aëre clauso manifestatur.

7. Flamma simpliciter compressa (licet sine flatu, ut in pulvere pyrio) tamen magis furit; ut conspici datur in fornacibus reverberatoriis, ubi flamma impeditur, arctatur, repercutitur, sinuat.

Monitum. Dilatationi per deacervationem non opponitur actio reciproca: quia corpora deacervata non coacervantur rursus, nisi per conflationem: ut in restitutione metallorum, de qua supra.

Commentatio.

Est et aliud genus fortasse contractionis corporum, non ex reciprocis sed positivum et per se. Arbitramur enim, in dissolutione corporum quæ fit in liquoribus, ut in dissolutione metallorum, etiam gummi, sacchari, et similium, recipi corpus aliquatenus intra liquorem; neque tamen liquorem pro rata parte corporis recepti dilatari aut exporrigi. Quod

[1] See the note on *Nov. Org.* ii. 45.

si fit, sequitur ut sit condensatio; cum idem spatium contineat plus corporis. Certe in dissolutione metallorum, si aqua semel exceperit onus suum, non dissolvit amplius, nec operatur. Hanc autem condensationem (si talis quæpiam sit) contractionem corporum per onerationem appellare possumus.

Mandatum. Immitte aquam in cineres pressos ad summum; et nota diligenter quantum decrescat de exporrectione cinerum, postquam receperint aquam, ab ea quam habuerunt prius intermisto aëre.

Observationes.

Efficientia dilatationis corporum, quæ ex inquisitione priore in lucem prodeunt, sunt novem. 1. Introceptio sive admissio corporis alieni. 2. Expansio naturalis, sive præternaturalis, spiritus innati. 3. Ignis, sive calor externus actualis; aut etiam remissio frigoris. 4. Calor externus potentialis, sive spiritus auxiliares. 5. Liberatio spirituum a vinculis partium. 6. Assimilatio ex imperio corporis rarioris magis activi. 7. Amplexus, sive itio in occursum corporis amici. 8. Distractio a violentia externa. 9. Deacervatio, sive applanatio partium.

Efficientia vero contractionis corporum sunt octo. 1. Exclusio aut depositio corporis introcepti. 2. Angustatio sive contractio partium post spiritum emissum. 3. Frigus externum actuale; aut etiam remissio caloris. 4. Frigus externum potentiale. 5. Fuga et antiperistasis. 6. Assimilatio ex imperio corporis densioris magis activi. 7. Compressio per violentiam externam. 8. Oneratio, si modo aliqua sit.

Actiones dilatationis per spiritum innatum, et per liberationem spirituum, et per deacervationem; atque rursus, actiones contractionis per constrictionem, sunt actiones sine reciproco. Reliquæ actiones sunt reciprocæ.

Dilatationes per introceptionem et per deacervationem sunt pseudo-dilatationes; sicut et contractiones per exclusionem, sunt pseudo-condensationes; sunt enim locales, non substantiales.

Expansio per ignem sive calorem sine separatione est omnium simplicissima: ea fit in pneumatico puro, sicut

aëre ; ubi nihil exhalat, nihil residet, sed mera fit dilatatio, eaque ad ampliationem spatii sive exporrectionis insignem. Utrum simile quippiam fiat in flamma, videlicet, utrum flamma post expansionem primæ accensionis (quæ est magna) jam facta flamma (ubi magnus est ambientium ardor) se adhuc magis expandat, difficile cognitu est, propter celerem et momentaneam extinctionem flammæ : verum de hoc in titulo de Flamma inquiremus. Proxima huic dilatationi (quatenus ad simplicitatem) est expansio quæ fit in colliquatione metallorum, aut in emollitione ferri et ceræ, et similium, ad tempus, antequam aliquid fiat volatile et emittatur. Verum hæc dilatatio occulta est, et fit intra claustra corporis integralis, nec visibiliter exporrectionem mutat aut ampliat. At simul ac incipiat in corpore aliquo quippiam evolare, tum actiones fiunt complicatæ, partim rarefacientes, partim contrahentes : adeo ut contrariæ illæ actiones ignis, quæ vulgo notantur,

> Limus ut hic durescit, et hæc ut cera liquescit,
> Uno eodemque igni,[1]

in hoc fundentur, quod in altera spiritus emittitur, in altera detinetur.

Condensatio quæ fit per ignem, licet non sit pseudo-densatio (est enim substantialis), tamen est condensatio potius secundum partes, quam secundum totum. Nam contrahuntur certe partes crassiores ; ita tamen ut corpus integrum reddatur magis cavum et porosum, et minus ponderosum.

Canones mobiles.

1. Summa materiæ in universo eadem manet ; neque fit transactio, aut a nihilo, aut ad nihilum.

2. Ex summa in aliquibus corporibus est plus, in aliquibus minus, sub eodem spatio.

3. Copia et paucitas materiæ constituunt notiones densi et rari, recte acceptas.

4. Est terminus, sive *non ultra*, densi et rari, sed non in ente aliquo nobis noto.

[1] Virg. Eclog. viii. 80.

5. Non est vacuum in natura, nec congregatum nec intermistum.

6. Inter terminos densi et rari est plica materiæ, per quam se complicat et replicat absque vacuo.

7. Differentiæ densi et rari in tangibilibus nobis notis parum excedunt rationes 32 partium.

8. Differentia a rarissimo tangibili ad densissimum pneumaticum habet rationem centuplam et amplius.

9. Flamma est aëre rarior, ut et oleum aqua.

10. Flamma non est aër rarefactus, ut nec oleum est aqua rarefacta; sed sunt plane corpora heterogenea, et non nimis amica.

11. Spiritus vegetabilium et animalium sunt auræ compositæ ex pneumatico aëreo et flammeo; quemadmodum et succi eorum ex aqueo et oleoso.

12. Omne tangibile apud nos habet pneumaticum, sive spiritum, copulatum et inclusum.

13. Spiritus, quales sunt vegetabilium et animalium, non inveniuntur apud nos soluti, sed in tangibili devincti et conclusi.

14. Densum et rarum sunt propria opificia calidi et frigidi; densum frigidi, rarum calidi.

15. Calor super pneumatica operatur per expansionem simplicem.

16. Calor in tangibili exercet duplicem operationem; semper dilatando pneumaticum, sed crassum interdum contrahendo, interdum laxando.

17. Norma autem ejus rei talis est: spiritus emissus corpus contrahit et indurat; detentus intenerat et colliquat.

18. Colliquatio incipit a pneumatico in corpore expandendo; aliæ dissolutiones a crasso, liberando operationem pneumatici.

19. Post calorem et frigus, potentissima sunt ad rarefactionem et condensationem corporum consensus et fuga.

20. Restitutio a violentia et dilatat et condensat, in adversum violentiæ.

21. Assimilatio et dilatat et condensat, prout est assimilans assimilato rarius aut densius.

22. Quo corpora sunt rariora, eo majorem sustinent et

dilatationem et contractionem per externam violentiam, ad certos terminos.

23. Si tensura aut pressura in corpore raro transgrediatur terminos sustinentiæ, tum corpora rariora potentius se vindicant in libertatem quam densiora, quia sunt magis activa.

24. Potentissima omnium expansio est expansio aëris et flammæ conjunctim.

25. Imperfectæ sunt dilatationes et contractiones, ubi facilis et proclivis est restitutio.

26. Densum et rarum magnum habent consensum cum gravi et levi.

27. Parce suppeditatur homini facultas ad condensationem, ob defectum potentis frigidi.

28. Ætas est instar ignis lambentis, et exequitur opera caloris, sed accuratius.

29. Ætas deducit corpora vel ad putrefactionem vel ad arefactionem.

Optativa cum proximis.

1. Versio aëris in aquam.

Proxima. Fontes in cavis montium. Exudatio lapidum. Roratio anhelitus. Vellus super latera navium, qu.[1] Meteora aquea, &c.

2. Augmentum ponderis in metallis.

Proxima. Versio ferri in cuprum, qu. Incrementum plumbi in cellis, qu. Versio argenti vivi in aurum, qu.

3. Insaxatio terræ, et materiarum ex vegetabilibus aut animalibus.

Proxima. Aqua insaxans. Lapis compositus ex lapidibus parvis incrustatis. Stillicidia crystallina in speluncis. Calculi in renibus et vesica et cyste fellis. Squamæ dentium.

4. Varii usus motus dilatantis et contrahentis in aëre per calorem.

Proxima. Vitrum calendare. Altare Heronis. Organum musicum splendentibus radiis solis. Impostura de imitatione fluxus et refluxus maris et amnium.

5. Inteneratio membrorum in animalibus per calorem proportionatum et spiritum detentum.

[1] See p. 292. § 7. — *J. S.*

Proxima. Emollitio ferri. Emollitio ceræ. Omnia amalagmata. Pertinet ad instaurationem juventutis: nam omnis humectatio, præter eam quæ fit ex spiritu nativo detento, videtur esse pseudo-inteneratio, et parum juvat; ut in proprio titulo videbimus.

Monitum. Parce proponimus sub isto titulo Optativa et Vellicationes de Praxi: quia cum sit tam generalis et late patens, magis idoneus est ad informandum judicium quam ad instruendam praxin.

INQUISITIO DE MAGNETE.

PREFACE

TO THE

INQUISITIO DE MAGNETE.

In Dr. Rawley's list of works composed by Bacon during the last five years of his life, the *Inquisitio de Magnete* stands last but two. The following fragment, first published by Dr. Rawley himself in 1658, and bearing that title, may be presumed to be the work in question. Though it seems to be only a sheet of notes, the place which it holds in the list implies that it was meant to be preserved; and therefore I place it here rather than in the third part, to which otherwise it might seem more properly to belong. It may be regarded as a loose leaf belonging to the third part of the Instauratio.

J. S.

INQUISITIO DE MAGNETE.

MAGNES trahit pulverem chalybis præparati, quali utuntur ad medicinam, etiam chalybem calcinatum in tenuissimum pulverem nigrum, æque fortiter ac limaturam ferri crudam: crocum autem Martis, qui est rubigo ferri artificiosa, hebetius et debilius. Si vero ferrum dissolvatur in aqua forti, et guttæ aliquæ dissolutionis ponantur super vitrum planum, non extrahit magnes ferrum, nec trahit aquam ipsam ferratam.

Magnes scobem suum trahit, quemadmodum limaturam ferri: parvaque admodum magnetis frustula, alterum alterum trahit, ut pensilia fiant, et capillata, quemadmodum acus.

Pone magnetem in tali distantia a ferro, ut non trahat: interpone pileum ferri, servata distantia, et trahet; virtute magnetis per ferrum melius diffusa, quam per medium aëris solius.

Magnes immissus intra aquam fortem, ibique per plures horas manens, virtute non minuitur.

Magnes fricatione contra pannum (ut utimur in electro), aut contra alium magnetem, aut calefactus ad ignem, virtute non augetur.

Magnes alius alio est longe virtuosior: quinetiam virtutem suam, pro modo ejus, ferro tactum transmittit: virtutem, inquam, non solum verticitatis, sed etiam attractionis simplicis. Nam si accipias magnetem fortiorem, eoque ferrum (puta cultellum) tangas, deinde magnete debiliore similiter alium cultellum, videbis cultellum fortiore magnete tactum majus trahere pondus ferri, quam qui debiliore tactus est.

Magnes ad æque distans ferrum trahit per aërem, aquam, vinum, oleum.

Magnete, aut pulvere ejus, in aqua forti immerso, nihil omnino dissolvitur, sicut in ferro fit; licet magnes videatur esse corpus ferro consubstantiale.

Pulvis magnetis ferrum intactum non trahit, nec tactum etiam: attamen ipse pulvis a ferro tacto trahitur, et adhæret; ab intacto autem minime: adeo ut pulvis magnetis videatur

passivam virtutem aliquo modo retinere, activam autem non omnino.

Acus super planum posita, quæ magnete non trahitur propter pondus, eadem superimposita fundo vitri elevato, ut utrinque propendeat, trahetur; quod eo magis relatu dignum puto, quia hujusmodi quiddam fortasse occasionem dedit frivolæ illi narrationi, quod adamas magnetis virtutem impediat. Pone enim acum super adamantem parvum, in tabulam sectum, magnete præsente ad distans majus quam in quo trahere posset, tamen trepidabit: illa autem trepidatio, non prohibitio motus est, sed motus ipse.

Magnes ferrum tactum longe vivacius trahit, quam intactum; adeo ut ferrum, quod intactum in data distantia non trahit, id in triplici distantia tactum trahat.

Nihil extrahitur ferri aut metallicæ materiæ ex magnete per ignem, et nota separationis.

Magnes non solvitur in aqua regis plus quam in aqua forti.

Magnes in crucibulo positus, citra tamen quam ut flammam immittat, minuitur multum pondere, et immensum virtute, ut vix ferrum attrahat.

Magnes ægre liquefit, sed tamen figuram nonnihil immutat, et rubescit ut ferrum.

Magnes combustus integer, virtutem passivam, ut se applicet alteri magneti, retinet; activam ad ferrum trahendum fere perdit.

Magnes in crucibulo combustus emittit fumum, vix tamen visibilem, qui laminam æris superimpositam nonnihil albicare facit: ut solent etiam metalla.

Magnes in comburendo penetrat per crucibulum, idque tam extra quam intra fracto, quod a splendore splendescere facit.

Consentiunt omnes, magnetem, si comburatur, ita ut flammam quandam luridam et sulphuream jaciat, prorsus fieri virtute evanidum; eamque nunquam postea recuperare; licet refrigeretur in positura australi, et septentrionali: id quod lateribus virtutem indit, et in magnetibus non prorsus combustis vires renovat.

Experimentum factum est, de ferro magnete tacto, ac etiam de magnete ipso, collocatis super fastigium templi S. Pauli Londini, quod est ex altissimis templis Europæ; annon minuerentur virtute attractiva, propter distantiam a terra? sed nihil prorsus variatum est.

TOPICA INQUISITIONIS

DE

LUCE ET LUMINE.

PREFACE

TO

TOPICA INQUISITIONIS DE LUCE ET LUMINE.

THE following paper of directions for an experimental inquiry concerning Light was first published by Gruter in 1653, among the pieces which he entitles *Impetus Philosophici;* afterwards (from another copy) by Dr. Rawley in 1658; and since a work with the same title is mentioned in Rawley's list of Bacon's later writings, where it stands last but one[1], I presume that this is it, and that it was meant to be preserved. If so, this is its proper place.

In my preface to the *Parasceve,* I have noticed Bacon's intention to draw up, with reference to the Natural and Experimental History which was to be the basis of the new philosophy, certain heads of inquiry showing what points in each subject were more particularly to be observed; and I have pointed out the importance of this part of his scheme, as bearing upon the question whether it were possible or not to procure a collection of the facts of nature in the manner he proposed. One example of the thing we have already seen, in the *Topica Particularis sive Articuli Inquisitionis de Gravi et Levi,* given in the fifth book of the *De Augmentis.* This is another; and though it does not profess to contain more than a few instances by way of example, it serves to show how he proposed to set about the work. If the enclosure transmitted in his letter to Father Baranzan, which related to a history of Comets (*de qua conficienda ecce tibi articulos quosdam et quasi topica particularia*), had been preserved, it would have supplied

[1] See Vol. I. p. 10. Mr. Ellis however infers from the allusion (infra, p. 317.) to *specula perspectiva*, that this tract must have been written before 1612. See his note. —*J. S.*

us with a third. It may be thought strange perhaps that he did no more during the last five years of his life towards the performance of a task, which in 1620 he talked of setting about as soon as he could find leisure[1], and which in 1623 he was still meditating.[2] But the sufficient explanation of the matter is, that he never had the offer of any help in making the proposed collections, and therefore the proposed directions would have been useless.

That the suggestions contained in the paper before us, which was probably drawn up with a view to the *Historia Visûs et Visibilium*, should retain any substantial value at the present day, was of course not to be expected. What value they may have had in Bacon's time, I do not know. But they remain to prove (if proof were wanting) that the system of observations and experiments from which he hoped to procure a collection of the facts of nature sufficient for the purposes of philosophy, was not to be carried on altogether without help from theory. They show also in what particular way he conceived that a communication between Theory and Observation might be established; and if the points upon which in this case he asks for information were not the most critical which might have been selected, it must have been owing to his imperfect acquaintance with what was then known about Light, not from any inherent impracticability in determining what next to ask, when one has a clear idea of what one wants next to know.

In the original, the numbers are placed before the first paragraph of each section, not before the headings. But as they belong properly to the sections, and not to the paragraphs, I have in this respect preferred the arrangement of Gruter's copy, where they are prefixed to the headings.

The notes to this fragment (except those marked with my initials) are Mr. Ellis's.

J. S.

[1] Enimvero cum primum huic rei vacare possimus, consilium est in singulis veluti interrogando docere, &c. — *Parasceve*, § 10.

[2] Nos autem Topicis Particularibus tantum tribuimus ut proprium opus de ipsis, in subjectis naturalibus dignioribus et obscurioribus, conficere in animo habemus. Domini enim quæstionum sumus, rerum non item. — *De Aug.* v. 3.

TOPICA INQUISITIONIS

DE

LUCE ET LUMINE.

I. *Tabula Præsentiæ.*

VIDENDUM primo, quæ sint ea, cujuscunque generis, quæ progignunt lucem: ut stellæ, meteora ignita, flamma, ligna, metalla et alia ignita, saccharum inter scalpendum et frangendum, cicendula, rores aquæ salsæ percussæ et sparsæ, oculi quorundam animalium, ligna nonnulla putria, magna vis nivis. Aër fortasse ipse tenuem possit habere lucem, animalium visui, quæ noctu cernunt, conformem. Ferrum et stannum, cum in aquam fortem immittuntur resolvenda, ebulliunt, et sine igne ullo acrem calorem concipiunt; utrum vero lucem aliquam edant, inquiratur. Oleum lampadum magnis frigoribus scintillat: nocte suda, circa equum sudantem, conspicitur nonnunquam lux quædam tenuis: circa capillos quorundam hominum accidit, sed raro, lux etiam tenuis, tanquam flammula lambens; ut factum est Lucio Martio in Hispania.[1] Ventrale cujusdam fœminæ nuper inventum est quod micaret, minime immotum, sed inter fricandum. Erat autem intinctum in viridi, atque tincturam illam ingreditur alumen, et crepabat nonnihil cum micabat. Utrum alumen inter scalpendum aut frangendum micet, inquiratur; sed fortiore (ut puto) indiget fractione quam saccharum, quia magis contumax est. Tibialia nonnulla inter exuendum nituerunt, sive ex sudore, sive ex tinctura aluminis. Alia.

II. *Tabula Absentiæ in proximo.*

Videndum etiam, quæ sint ea quæ nullam lucem edant, quæ tamen cum iis quæ edant magnam habent similitudinem.

[1] Livy, xxv. 39.

Aqua bulliens non edit lucem. Aër licet violenter fervefactus non edit lucem. Specula et diamantes, quæ lucem tam insigniter reflectunt, nullam edunt lucem originalem. Alia.

Videndum est etiam accurate, in hoc genere instantiarum, de instantiis *migrantibus*, ubi scilicet adest et abest lux, quasi transiens. Carbo ignitus lucet, sed fortiter compressus statim lucem deponit. Humor ille crystallinus cicendulæ, morte vermis, etiam fractus et in partes divisus, lucem ad parvum tempus retinet, sed quæ paulo post evanescat. Alia.

III. *Tabula Graduum.*

Videndum quæ lux sit magis intensa et vibrans, quæ minus. Flamma lignorum fortem edit lucem; flamma spiritus vini debiliorem; flamma carbonum penitus accensorum, fuscam admodum et vix visibilem. Alia.

IV. *Colores Lucis.*

Videndum est de coloribus lucis, quales sint, quales non. Stellarum aliæ candidæ sunt, aliæ splendidæ, aliæ rubeæ, aliæ plumbeæ. Flammæ ordinariæ fere croceæ sunt[1], et inter eas coruscationes cœlitus, et flammæ pulveris pyrii maxime albicant. Flamma sulphuris cœrulea est et pulchra. In aliquibus autem corporibus sunt purpureæ flammæ. Non inveniuntur flammæ virides.[2] Quæ maxime ad viriditatem inclinat, est lux cicendulæ. Nec inveniuntur coccineæ flammæ. Ferrum ignitum rubicundum est, et paulo intensius ignitum quasi candescit. Alia.

V. *Reflexiones Lucis.*

Videndum quæ corpora lucem reflectunt; ut specula, aquæ, metalla polita, luna, gemmæ. Omnia liquida, et superficie valde æquata et levi, splendent nonnihil. Splendor autem est gradus quidam pusillus luminis.

Videndum attente, utrum lux corporis lucidi ab alio corpore lucido reflecti possit: ut si sumatur ferrum ignitum, et opponatur radiis Solis. Nam reflexiones lucis omnino super-reflectuntur (elanguentes[3] tamen paulatim) de speculo in speculum. Alia.

[1] So Gruter's copy. In Rawley's the words *fere croceæ sunt* are omitted, probably by mistake. —*J. S.*

[2] Green flames for fireworks are produced by means of copper, which is sometimes employed in a metallic state, and sometimes in verdigris or in vitriol.

[3] *Elanguentia* in Rawley's copy. —*J. S.*

VI. *Multiplicationes Lucis.*

Videndum de multiplicatione lucis, ut per specula perspectiva et similia[1], quibus acui potest lux et in longinquum projici, aut etiam reddi ad distinguendas res visibiles subtilius et melius[2]; ut videre est apud pictores, qui phialam aqua plenam ad candelam adhibent.

Videndum etiam, num omnia in majore quanto lucem non reflectant. Lux enim (ut credi possit) aut pertransit aut reflectitur. Qua de causa luna, etiamsi fuerit corpus opacum, tamen ob magnitudinem lucem reflectere possit.

Videndum etiam, utrum aggregatio corporum lucidorum lucem multiplicet. Atque de æqualiter lucidis, dubitandum non est. Utrum vero lux quæ majore luce plane obruitur, ut videri per se non possit, adjiciat tamen aliquid lucis, inquiratur. Etiam splendida quæque nonnihil lucis contribuunt. Magis enim lucidum erit cubiculum serico quam lana ornatum. Multiplicatur etiam lux per refractionem: nam gemmæ angulis intercisæ, et vitrum fractum, magis splendent quam si plana fuerint. Alia.

VII. *Modi obruendi lucem.*

Videndum de modis obruendi lucem; veluti per exuperantiam majoris lucis, mediorum crassitudines et opacitates. Radii solis certe, in flammam foci immissi, flammam veluti fumum quendam albiorem apparere faciunt. Alia.

VIII. *Operationes sive Effectus Lucis.*

Videndum de operationibus sive effectibus lucis, qui pauci sunt; et ad corpora, præsertim solida, alteranda parum possunt. Lux enim præ omnibus se generat, alias qualitates parce.

Lux certe aërem nonnihil attenuat; spiritibus animalium grata est, eosque exhilarat; colorum omnium et visibilium radios submortuos excitat. Omnis enim color, lucis imago fracta est. Alia.

IX. *Mora Lucis.*

Videndum est de mora lucis; quæ, ut videtur, momentanea est. Neque enim lux, si per multas horas in cubiculo duraverit, magis illud illuminat, quam si per momentum aliquod;

[1] This does not appear to refer to telescopes, but merely to bringing to a focus light incident on a convex lens. Consequently this tract seems to have been written before Bacon was acquainted with the invention of the telescope, and consequently before 1612. See the Preface to the *Descriptio Globi intellectualis.*

[2] *Mollius* in Gruter's copy.—*J. S.*

cum in calore et aliis contra fiat. Etenim et prior calor manet, et novus superadditur. Attamen crepuscula nonnihil a reliquiis lucis[1] provenire ab aliquibus putantur.

X. *Viæ et Processus Lucis.*

Videndum attente de viis et processibus lucis. Lux circumfunditur; utrum vero una ascendat paululum, an æqualiter deorsum et sursum circumfundatur, inquiratur. Lux ipsa lucem undique circa se parit; ut cum corpus lucis, umbraculo scilicet interposito, non cernatur, lux ipsa tamen omnia circum illuminat, præter ea quæ sub umbram umbraculi cadunt; quæ tamen ipsa nonnihil lucis accipiunt a luce circumjecta; nam multo melius aliquid intra umbram umbraculi situm cerni potest, quam si nulla omnino adesset lux. Itaque corpus visibile corporis alicujus lucidi, et ipsa lux, res discrepantes esse videntur. Lux corpora fibrosa et inæqualis posituræ non penetrat; sed tamen a soliditate duritiæ corporis non impeditur, ut fit in vitro et similibus. Itaque recta linea, et pori non transversi, videntur lucem tantum perferre.

Delatio lucis fit optime per aërem; qui quo purior fuerit, eo melius lucem transmittit. Utrum lux per corpus aëris vehatur, inquiratur. Sonos certe videmus a ventis vehi, ut[2] longius secundo vento quam adverso audiri possint. Utrum vero simile aliquid fiat in luce, inquiratur. Alia.

XI. *Diaphaneitas lucidorum.*

Videndum est etiam de diaphaneitate lucidorum. Filum candelæ intra flammam cernitur: at per majores flammas objecta ad visum non perveniunt. At contra, omnis diaphaneitas ex corpore aliquo ignito perit; ut in vitro videre est, quod ignitum non amplius manet diaphanum. Corpus aëris diaphanum est; item aquæ: at illa duo diaphana commista, in nive aut spuma, non amplius diaphana sunt, sed acquirunt lucem quandam originalem.

XII. *Cognationes et Hostilitates Lucis.*

Videndum de cognationibus atque etiam hostilitatibus lucis. Cognationem maxime habet lux cum tribus rebus, quatenus ad generationem lucis; calore, tenuitate, et motu.[3] Videndum

[1] *Solis* in Gruter's copy.—*J. S.*

[2] So Gruter's copy. Rawley's has *et.*—*J. S.*

[3] This quaternion of qualities, light, heat, tenuity, and motion, is a fundamental part of the philosopy of Telesius. See his *De Rer. Nat.* i. passim.

igitur de conjugiis et divortiis eorum erga lucem, atque eorundem conjugiorum et divortiorum gradibus. Flamma spiritus vini, aut ignis fatui, longe ferro ignito calore lenior est, verum lumine fortior. Cicendulæ et rores aquæ salsæ, et multa ex illis quæ enumeravimus, lucem jaciunt, calida ad tactum non sunt. Etiam metalla ignita tenuia non sunt, at calore tamen ardente prædita. At contra aër est inter tenuissima corpora, sed luce vacat. Rursus idem aër, atque etiam venti, motu rapidi sunt, lucem tamen non præbent. At contra, metalla ignita motum suum hebetem non exuunt, lucem nihilominus vibrant.

In cognationibus autem lucis, quæ non ad generationem ejus, sed ad processum tantum spectant, nihil tam conjunctum est quam sonus. Itaque de eorum sympathiis et dissidiis accurate videndum. In his conveniunt. Lux et sonus in ambitum circumfunduntur. Lux et sonus per longissima spatia feruntur, sed lux pernicius; ut in tormentis videmus, ubi lux citius cernitur quam auditur sonus, cum tamen flamma pone sequatur. Lux et sonus subtilissimas distinctiones patiuntur; ut in verbis articulatis soni, in omnibus visibilium imaginibus lux. Lux et sonus nihil fere producunt aut generant, præterquam in sensibus et spiritibus animalium. Lux et sonus facile generantur et brevi evanescunt. Nam non est quod quis putet sonum illum qui ad tempus aliquod a campana aut chorda percussa durat, a prima percussione fieri. Nam si campana vel chorda tangatur, et sistatur, sonus statim perit. Unde manifestum est, durationem soni [1] per successionem creari. Lux a majore luce, sicut sonus a majore sono, obruitur; et cætera.

Differunt autem, quod lux (ut diximus) sono velocior sit. Lux majora spatia vincat quam sonus. Lux utrum in corpore aëris deferatur, quemadmodum sonus, incertum sit. Lux in linea recta tantum, sonus in linea obliqua et undiquaque, feratur: etenim cum quid in umbra umbraculi cernitur, non est quod quis putet quod lux ipsa penetret umbraculum, sed aërem tantum circumfusum illuminat; qui etiam aërem pone umbraculum vicinitatę nonnihil illustrat: at sonus ab uno latere parietis redditus, ex altera parte parietis auditur, non multum debilitatus. Etiam sonus intra septa corporum solidorum auditur, licet exilior factus; ut fit in sonis infra lapides hæmatites, aut in corporibus percussis infra aquam; at lux in

[1] So Gruter's copy: the words *durationem soni* are omitted in Rawley's. — *J. S.*

corpore solido et non[1] diaphano, undique obstructo, omnino non cernitur. Ultimo, quod[2] omnis sonus generetur in motu, et elisione corporum manifesta; lux non item.

At hostilitates lucis, nisi quis privationes pro hostilitatibus habere velit, non occurrunt; verum quod maxime credibile est, torpor corporum in partibus suis maxime est luci inimicus. Nam fere nihil lucet, quod non aut propria natura insigniter mobile est; aut excitatum vel calore vel motu vel spiritu vitali. Alia.

Intelligo autem semper, quod non tantum aliæ instantiæ investigandæ sint (istas enim paucas exempli loco solummodo adduximus) sed etiam ut novi topici articuli, prout rerum natura fert, adjiciantur.

[1] So Gruter's copy: the words *solido et non* are omitted in Rawley's. — *J. S.*

[2] Gruter's copy has *Lux magis in profundum penetrat quam sonus; ut in fundo aquarum. Omnis sonus generatur, &c.* — *J. S.*

SYLVA SYLVARUM.

PREFACE

TO

THE SYLVA SYLVARUM.

BY ROBERT LESLIE ELLIS.

In 1627, the year after that in which Bacon died, his chaplain Dr. Rawley published the *Sylva Sylvarum*. The preface is Rawley's own, and was written in Bacon's lifetime; it gives some account of Bacon's views touching the kind of natural history required as the foundation of the instauration of the sciences, but contains little or nothing which is not found elsewhere. Although Rawley says that in the present work the materials for the building are collected, yet it cannot be doubted but that Bacon was fully conscious that, even taken in conjunction with the treatises *De Ventis* and *De Vitâ et Morte*, &c., the *Sylva Sylvarum* falls far short of his own idea of a just and perfect Natural History. We should do him injustice if we were to suppose that he was satisfied with the collection of facts here published, of which much the greater part are taken from a few popular writers. We ought rather to regard it as a proof that Bacon's thoughts were busied, up to the close of life, with his plan for the reform of philosophy, and as the work of a man who, knowing that he could not accomplish his own designs, was yet resolved, in spite of worldly troubles and of increasing infirmities, to labour on in the good cause which he had so long had in hand. That it was Bacon's last work gives it a peculiar interest, though the habits of thought which in the seventeenth century made it a popular book have long since passed away. Curiosity about isolated or slightly connected facts seems gradually to decline, as scien-

tific notions become more generally diffused; the interest which we feel in any phenomenon is much impaired, when we know that however marvellous it may seem to us it can nevertheless be intelligibly explained. Men learn by degrees to leave off wondering, and to seek for causes, or trust for information to those who do. At present, popular books on science attempt for the most part to make abstract theories intelligible, or at least to give an account of what these theories are about. But in Bacon's time, and still more at an earlier period, men delighted in nothing more than in collections of remarkable facts; the more marvellous, so they did not become altogether incredible, the better. In those days men were much more nearly on a level in scientific matters than they are now; and the reader of Mizaldus or of John Baptist Porta was not mortified by the reflection that his wonder was only the result of his own ignorance. All men were, as it seemed, equally ignorant of the occult causes of phenomena, and if any explanation was offered it was such as all men could equally understand. For at best these explanations involved only loose and popular notions of force and motion, and for the most part they merely referred the phenomena to sympathy and antipathy, the influence of the stars, specific forms, and the like, of which principles the modus operandi was, by the consent of all men, held undiscoverable. To this class of writings the *Sylva Sylvarum* seems naturally to belong, and, in truth, a considerable part of it is copied from the most celebrated book of the kind, namely Porta's *Natural Magic*. It has doubtless a more scientific character than the average of similar works, but there are some to which in this and in other respects it is decidedly inferior. I refer particularly to Cardan's *De Subtilitate*, and to his *De Rerum Varietate*. Both of them supplied some of the facts mentioned in the *Sylva Sylvarum*.

I may be allowed to digress for a moment from the *Sylva Sylvarum* to a subject of considerable interest, namely the facility with which miraculous stories were received in the middle ages. We are apt to regard this as a proof of the prevalence of gross superstition; whereas in reality miracles were simply believed like other marvels. The habit of asking *how* effects are produced had then no existence, and consequently the *à priori* difficulty which hinders men from believing

in wonderful stories, except on commensurate evidence, was never felt. Every one believed, for instance, that bleeding might be stopped by touching the wounded man with a blood-stone, — why might not the same effect be produced by the relic of a saint? And so in all similar cases. The *à priori* conceivability of any assertion is one of the circumstances by which men are decided in believing or disbelieving it; but this operates differently according to the mental habits of different men. The subject cannot here be pursued farther, though, from its connexion with the application of the theory of probabilities to questions of evidence, it is by no means unimportant.

The *Sylva Sylvarum* consists of one thousand paragraphs, and is divided into ten centuries. Each of these paragraphs contains a statement of one or more facts, accompanied generally by some remarks tending more or less to explain the causes of the observed phenomena. The facts themselves are derived from a variety of sources; some from Bacon's own observation, some perhaps from oral report, and the remainder from books. In many places they seem to have been noted down as the book from which they are taken was read; at least they occur in the same order as in the original work. The principal sources are Aristotle's *Problems*, his *De mirabilibus auscultationibus* (not genuine), and his *Meteorologics;* Pliny's *Natural History*, Porta's *Natural Magic*, and Sandys's *Travels*. To these are to be added Cardan *De Subtilitate*, Scaliger *Adversus Cardanum*, and one or two others. The *Natural Magic* contributes more than any other book, and next to it, I think, Aristotle's *Problems*.

The route which Sandys, whose book was published in 1615, followed in his travels may almost be traced in Bacon's extracts. Thus, in (701) he is at Lemnos, from whence he proceeds in the next two paragraphs up the Dardanelles to Constantinople. In (704) and (705) we find some mention of what he saw there; a subject resumed in (738) and continued to (741). In (743) he has reached Egypt, where he is found again in (767) and the next paragraph. The succeeding sixteen paragraphs follow him, with some admixture of extraneous matter, through Syria and Palestine to Sicily and the neighbourhood of Naples.

From Cardan is taken the great mass of what is said in the tenth century touching sympathy and antipathy. One or two

curious stories Bacon adds from his own experience, and he also mentions two remarkable cases of instinctive divination. Of these the first is the story told in the life of Angelo Caltho, prefixed to some editions of Comines's *Memoirs*, namely that he announced the death of Charles the Bold at the very time at which it took place: the other is mentioned in Catena's *Life of Pius V.*,—that he knew of the victory at Lepanto as soon as it was won. For the first story Bacon refers to Comines, who says nothing about it, and whose silence is all but conclusive against its truth [1]; for the second he gives no authority, but there is no doubt but that he derived it from Catena, with whose book he was in all probability acquainted, as what he says of Pius V. in the beginning of the *Advancement of Learning* is taken from it.

Porta's *Natural Magic* supplied Bacon with almost all he says of the changes which may be produced in fruits and other vegetable products by peculiar modes of cultivation. In some of the paragraphs taken from Porta he refers to "one of the ancients," the reason of which is that almost all Porta's statements are supported by reference to a Greek or Latin author. If we did not know the channel through which his information is derived, we might give him credit for much curious research. Thus in (458) he observes that it is reported by one of the ancients that artichokes will be less prickly if their tops have been grated off upon a stone. The writer referred to is Varro, but the statement is only preserved in the *Geoponica*; it does not occur in any part of his works now extant. As the *Geoponica* are certainly not often read or even quoted, it would have been interesting to know that Bacon was acquainted with them. Unfortunately, on looking into the *Natural Magic*, we find that Bacon was in this case simply a transcriber.

The statements taken from Aristotle's *Problems* relate, like the problems themselves, to a great variety of subjects. Bacon does not adopt Aristotle's solutions, at least not generally, but after stating affirmatively the fact of which Aristotle inquires

[1] The misfortunes of the Duke of Burgundy are recorded in four curious lines, written apparently by a contemporary. They are manifestly corrupt, but may perhaps be thus restored:—

Nix Burgundo nocuit
Sed Gransen grande gravavit
Morat momordit
Quem lancea Nancy necavit.

KELLER's *Rompart*, p. 157.

the cause, he gives his own explanation of it, often introducing it by the formula, "the reason is, &c.," which is, I think, not employed except in paragraphs taken from or suggested by something in the *Problems*. The paragraphs from (837) to (846) are evidently the result of Bacon's having been reading the fourth book of the *Meteorologics*, but they consist less of statements of facts than of speculations relating to familiarly known phenomena.

Pliny's *Natural History* supplied Bacon with many remarks on agriculture and kindred subjects.

The description of the chameleon in (360) is clearly taken from Scaliger's *Exercitationes adversus Cardanum*, and in another paragraph (694) he mentions Scaliger by name, and approves of something which is said in the same work. Scaliger and Comines are, I think, the only two modern writers mentioned in the *Sylva Sylvarum*.

In the paragraphs of the second century, which relate to music, Bacon refers to the controversy as to whether the interval of the fourth ought to be considered a harmony. There are a number of books by which this question may have been suggested to him, but it is impossible to know which of them he had read. His opinion in favour of the fourth is quoted with great approbation by [Charles Butler, of Magdalen College, Oxford, in his *Principles of Music* (1636). See note on Exp. 107.]

In concluding these desultory remarks it may be well to observe that the name Sylva Sylvarum seems to be a Hebraism for optima sylva[1]; sylva being used as ὕλη in Greek for the materials out of which anything is to be constructed. The name therefore accords with Bacon's notion of natural history; namely that it ought to supply the materials with which the new philosophy is to be built up.

[1] I should rather take it to mean *a collection of collections*; that is, a variety of Sylvæ (or collections of facts relating to particular subjects) gathered together. Almost all the experiments concerning sound, which extend from 100 to 290, are to be found in a Latin fragment which has *Sylva Soni et Auditus* for one of its titles. That is one of the *Sylvæ* of which this *Sylva Sylvarum* is made up.— *J. S.*

SYLVA SYLVARUM:

OR

A NATURAL HISTORY.

IN TEN CENTURIES.

WRITTEN BY THE RIGHT HONOURABLE

FRANCIS LORD VERULAM, VISCOUNT ST. ALBAN.

PUBLISHED AFTER THE AUTHOR'S DEATH

BY

WILLIAM RAWLEY, DOCTOR OF DIVINITY,

LATE HIS LORDSHIP'S CHAPLAIN.

LONDON:

Printed by J. H. for William Lee at the Turk's Head in Fleet Street, next to the Mitre.

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TO

THE MOST HIGH AND MIGHTY

PRINCE CHARLES,

BY THE GRACE OF GOD,

KING OF GREAT BRITAIN, FRANCE, AND IRELAND,

DEFENDER OF THE FAITH, ETC.

May it please Your Most Excellent Majesty,

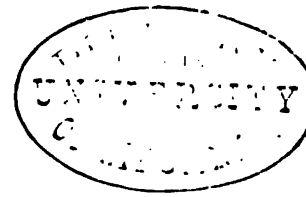
THE whole body of the *Natural History*, either designed or written by the late Lord Viscount St. Alban, was dedicated to Your Majesty, in his book *De Ventis*, about four years past, when Your Majesty was Prince: so as there needed no new dedication to this work, but only in all humbleness to let Your Majesty know it is yours. It is true, if that Lord had lived, Your Majesty ere long had been invoked to the protection of another History; whereof, not Nature's kingdom, as in this, but these of Your Majesty's (during the time and reign of King Henry the Eighth) had been the subject; which since it died under the designation merely, there is nothing left but Your Majesty's princely goodness, graciously to accept of the undertaker's heart and intentions; who was willing to have parted for a while with his darling philosophy, that he might have attended your royal commandment in that other work. Thus much I have been bold in all lowliness to represent unto

Your Majesty, as one that was trusted with his Lordship's writings even to the last. And as this work affecteth the stamp of Your Majesty's royal protection, to make it more current to the world; so under the protection of this work, I presume in all humbleness to approach Your Majesty's presence, and to offer it up into your sacred hands.

Your Majesty's most loyal

and devoted subject,

W. RAWLEY.



TO THE READER.

HAVING had the honour to be continually with my lord in compiling of this work, and to be employed therein, I have thought it not amiss (with his lordship's good leave and liking), for the better satisfaction of those that shall read it, to make known somewhat of his lordship's intentions touching the ordering and publishing of the same. I have heard his lordship often say, that if he should have served the glory of his own name, he had been better not to have published this Natural History: for it may seem an indigested heap of particulars, and cannot have that lustre which books cast into methods have; but that he resolved to prefer the good of men, and that which might best secure it, before anything that might have relation to himself. And he knew well that there was no other way open to unloose men's minds, being bound and, as it were, maleficiate by the charms of deceiving notions and theories, and thereby made impotent for generation of works, but only nowhere to depart from the sense and clear experience; but to keep close to it, especially in the beginning: besides, this Natural History was a debt of his, being designed and set down for a third part of the Instauration. I have also heard his lordship discourse that men (no doubt) will think many of the experiments contained in this collection to be vulgar and trivial, mean and sordid, curious and fruitless: and therefore, he wisheth that they would have perpetually before their eyes what is now in doing, and the difference between this Natural History and others. For those Natural Histories which are extant, being gathered for delight and use, are full of pleasant descriptions and pictures, and affect and seek after admiration, rarities, and secrets. But, contrariwise, the scope which his lordship intendeth, is to write such a Natural History as may be fundamental to the erecting and building of a

true philosophy; for the illumination of the understanding, the extracting of axioms, and the producing of many noble works and effects. For he hopeth by this means to acquit himself of that for which he taketh himself in a sort bound, and that is, the advancement of all learning and sciences. For, having in this present work collected the materials for the building, and in his Novum Organum (of which his lordship is yet to publish a second part) set down the instruments and directions for the work; men shall now be wanting to themselves, if they raise not knowledge to that perfection whereof the nature of mortal men is capable. And in this behalf, I have heard his lordship speak complainingly, that his lordship (who thinketh he deserveth to be an architect in this building) should be forced to be a workman and a labourer, and to dig the clay and burn the brick; and more than that, (according to the hard condition of the Israelites at the latter end) to gather the straw and stubble over all the fields to burn the bricks withal. For he knoweth, that except he do it, nothing will be done: men are so set to despise the means of their own good. And as for the baseness of many of the experiments; as long as they be God's works, they are honourable enough. And for the vulgarness of them, true axioms must be drawn from plain experience and not from doubtful; and his lordship's course is to make wonders plain, and not plain things wonders; and that experience likewise must be broken and grinded, and not whole, or as it groweth. And for use; his lordship hath often in his mouth the two kinds of experiments, *experimenta fructifera* and *experimenta lucifera:* experiments of Use, and experiments of Light: and he reporteth himself, whether he were not a strange man, that should think that light hath no use, because it hath no matter. Further, his lordship thought good also to add unto many of the experiments themselves some gloss of the causes: that in the succeeding work of interpreting nature and framing axioms, all things may be in more readiness. And for the causes herein by him assigned; his lordship persuadeth himself, they are far more certain than those that are rendered by others; not for any excellency of his own wit (as his lordship is wont to say), but in respect of his continual conversation with nature and experience. He did consider likewise, that by this addition of causes, men's minds (which make so much haste to find out the causes of

things) would not think themselves utterly lost in a vast wood of experience, but stay upon these causes (such as they are) a little, till true axioms may be more fully discovered. I have heard his lordship say also, that one great reason why he would not put these particulars into any exact method (though he that looketh attentively into them shall find that they have a secret order) was because he conceived that other men would now think that they could do the like, and so go on with a further collection; which, if the method had been exact, many would have despaired to attain by imitation. As for his lordship's love of order, I can refer any man to his lordship's Latin book, *De Augmentis Scientiarum;* which (if my judgment be anything) is written in the exactest order that I know any writing to be. I will conclude with an usual speech of his lordship's; That this work of his Natural History is the world as God made it, and not as men have made it; for that it hath nothing of imagination.

W. RAWLEY.

This epistle is the same that should have been prefixed to this book if his lordship had lived.

NATURAL HISTORY.

CENTURY I.

Experiments in consort touching the straining and passing of bodies one through another; which they call Percolation.

1. DIG a pit upon the sea-shore, somewhat above the high-water mark, and sink it as deep as the low-water mark; and as the tide cometh in, it will fill with water, fresh and potable. This is commonly practised upon the coast of Barbary, where other fresh water is wanting. And Cæsar knew this well when he was besieged in Alexandria: for by digging of pits in the sea-shore, he did frustrate the laborious works of the enemies, which had turned the sea-water upon the wells of Alexandria; and so saved his army, being then in desperation.[1] But Cæsar mistook the cause, for he thought that all sea-sands had natural springs of fresh water. But it is plain that it is the sea-water; because the pit filleth according to the measure of the tide[2]; and the sea-water passing or straining through the sands leaveth the saltness.

2. I remember to have read that trial hath been made of salt water passed through earth, through ten vessels one within another, and yet it hath not lost his saltness, as to become potable: but the same man saith, that (by the relation of another) salt water drained through twenty vessels hath become fresh.[3] This experiment seemeth to cross that other of pits

[1] Hirtius, De Bello Alexandrino, c. 8. and 9.; and see Aristot. Prob. sect. xxiii. 21. and 37.

[2] Wells of fresh water close upon the sea shore sometimes ebb and flow with the tide. But this arises from the comparative levity of the fresh water, in consequence of which it is, so to speak, floated up when the tide comes in. Or it may arise from the presence of compressed air in the interstices of the soil which lies between the fresh and the salt water; an explanation which appears to be confirmed by recent experiments on the subject of drainage.

[3] This statement is taken from J. B. Porta. See his *Natural Magic*, xx. 1. Aristotle, in support of the opinion that fish are nourished by the fresh water present in the sea, states that a closed vessel of thin wax immersed for a certain time in the sea

made by the sea-side; and yet but in part, if it be true that twenty repetitions do the effect. But it is worth the note, how poor the imitations of nature are in common course of experiments, except they be led by great judgment, and some good light of axioms. For first, there is no small difference between a passage of water through twenty small vessels, and through such a distance as between the low-water and high-water mark. Secondly, there is a great difference between earth and sand; for all earth hath in it a kind of nitrous salt, from which sand is more free; and besides earth doth not strain the water so finely as sand doth. But there is a third point that I suspect as much or more than the other two; and that is, that in the experiment of transmission of the sea-water into the pits the water riseth; but in the experiment of transmission of the water through the vessels it falleth. Now, certain it is that the salter part of water (once salted throughout) goeth to the bottom. And therefore no marvel if the draining of water by descent doth not make it fresh. Besides, I do somewhat doubt that the very dashing of the water that cometh from the sea is more proper to strike off the salt part, than where the water slideth of her own motion.

3. It seemeth percolation, or transmission, (which is commonly called *straining*) is a good kind of separation; not only of thick from thin, and gross from fine, but of more subtile natures; and varieth according to the body through which the transmission is made: as if through a woollen bag, the liquor leaveth the fatness; if through sand, the saltness, &c. They speak of severing wine from water, passing it through ivy wood, or through other the like porous body; but *non constat.*[1]

4. The gum of trees (which we see to be commonly shining and clear) is but a fine passage or straining of the juice of the tree through the wood and bark. And in like manner, Cornish diamonds and rock rubies (which are yet more resplendent than gums) are the fine exudations of stone.

5. Aristotle giveth the cause, vainly, why the feathers of birds are of more lively colours than the hairs of beasts; for no beast hath any fine azure, or carnation, or green hair. He saith, it is because birds are more in the beams of the sun than

is found to contain fresh water. If this is true, the explanation probably is, that the temperature of the sea at the depth to which the vessel is sunk happens to be below the dew point of the air at the surface.

[1] Pliny, xvi. 63.; and Cato, De Re Rusticâ, cxi.

beasts[1]; but that is manifestly untrue; for cattle are more in the sun than birds, that live commonly in the woods, or in some covert. The true cause is, that the excrementitious moisture of living creatures, which maketh as well the feathers in birds as the hair in beasts, passeth in birds through a finer and more delicate strainer than it doth in beasts: for feathers pass through quills; and hair through skin.

6. The clarifying of liquors by adhesion is an inward percolation; and is effected when some cleaving body is mixed and agitated with the liquors; whereby the grosser part of the liquor sticks to that cleaving body, and so the finer parts are freed from the grosser. So the apothecaries clarify their syrups by whites of eggs, beaten with the juices which they would clarify; which whites of eggs gather all the dregs and grosser parts of the juice to them; and after the syrup being set on the fire, the whites of eggs themselves harden, and are taken forth. So hippocras[2] is clarified by mixing with milk, and stirring it about, and then passing it through a woollen bag, which they call Hippocrates Sleeve; and the cleaving nature of the milk draweth the powder of the spices and grosser parts of the liquor to it; and in the passage they stick upon the woollen bag.

7. The clarifying of water is an experiment tending to health; besides the pleasure of the eye, when water is crystalline. It is effected by casting in and placing pebbles at the head of a current, that the water may strain through them.

8. It may be, percolation doth not only cause clearness and splendour, but sweetness of savour; for that also followeth as well as clearness, when the finer parts are severed from the grosser. So it is found, that the sweats of men that have much heat, and exercise much, and have clean bodies and fine skins, do smell sweet; as was said of Alexander[3]; and we see commonly that gums have sweet odours.

[1] Rather that hair is not susceptible of the action of the sun's rays as feathers are. See Aristot. De Coloribus, 6. It is remarkable that almost, if not absolutely, the only case in which hair exhibits something of the iridescent lustre of which the feathers of birds and the scales of fishes offer so many examples, is that of an animal of burrowing habits; the chrysochloris or cape mole, of which several species are known.

[2] Hippocras was made by boiling together red wine and spice. Its name is of course derived from its being strained in the manner described in the text. See Strutt, Manners and Customs, iii. 74. and compare Hippocrates, De Affectionibus, ii. p. 420. of Kuhn's edition.

[3] Plutarch in Alexandr. p. 666. Lord Herbert of Cherbury affirms that his personal attendants could testify that he possessed this advantage.

Experiments in consort touching motion of bodies upon their pressure.

9. Take a glass, and put water into it, and wet your finger, and draw it round about the lip of the glass, pressing it somewhat hard; and after you have drawn it some few times about, it will make the water frisk and sprinkle up in a fine dew. This instance doth excellently demonstrate the force of compression in a solid body. For whensoever a solid body (as wood, stone, metal, &c.) is pressed, there is an inward tumult in the parts thereof, seeking to deliver themselves from the compression. And this is the cause of all violent motion. Wherein it is strange in the highest degree, that this motion hath never been observed nor inquired; it being of all motions the most common, and the chief root of all mechanical operations. This motion worketh in round at first, by way of proof and search which way to deliver itself; and then worketh in progress, where it findeth the deliverance easiest. In liquors this motion is visible; for all liquors strucken make round circles, and withal dash; but in solids (which break not) it is so subtile, as it is invisible; but nevertheless bewrayeth itself by many effects; as in this instance whereof we speak.[1] For the pressure of the finger, furthered by the wetting (because it sticketh so much the better unto the lip of the glass) after some continuance, putteth all the small parts of the glass into work, that they strike the water sharply; from which percussion that sprinkling cometh.

10. If you strike or pierce a solid body that is brittle, as glass or sugar, it breaketh not only where the immediate force is; but breaketh all about into shivers and fitters; the motion, upon the pressure, searching all ways, and breaking where it findeth the body weakest.

11. The powder in shot, being dilated into such a flame as endureth not compression, moveth likewise in round, (the flame being in the nature of a liquid body) sometimes recoiling, sometimes breaking the piece, but generally discharging the bullet, because there it findeth easiest deliverance.

12. This motion upon pressure, and the reciprocal thereof, which is motion upon tensure, we use to call (by one common

[1] The solution of continuity of the earth's surface, observed in violent earthquakes, has been referred by Humboldt to this class of phenomena; the earthquake being in fact, as Æschylus might have called it, a *κῦμα χερσαῖον*.

name) *motion of liberty;* which is, when any body, being forced to a preternatural extent or dimension, delivereth and restoreth itself to the natural: as when a blown bladder (pressed) riseth again; or when leather or cloth tentured spring back. These two motions (of which there be infinite instances) we shall handle in due place.

13. This motion upon pressure is excellently also demonstrated in sounds; as when one chimeth upon a bell, it soundeth; but as soon as he layeth his hand upon it, the sound ceaseth. And so the sound of a virginal string, as soon as the quill of the jack falleth from it, stoppeth. For these sounds are produced by the subtile percussion of the minute parts of the bell or string upon the air; all one, as the water is caused to leap by the subtile percussion of the minute parts of the glass upon the water, whereof we spake a little before in the ninth experiment. For you must not take it to be the local shaking of the bell or string that doth it: as we shall fully declare when we come hereafter to handle sounds.

Experiments in consort touching separations of bodies by weight.[1]

14. Take a glass with a belly and a long neb; fill the belly (in part) with water: take also another glass, whereinto put claret wine and water mingled; reverse the first glass, with the belly upwards, stopping the neb with your finger; then dip the mouth of it within the second glass, and remove your finger. continue it in that posture for a time; and it will unmingle the wine from the water: the wine ascending and settling in the top of the upper glass; and the water descending and settling in the bottom of the lower glass.[2] The passage is apparent to the eye; for you shall see the wine, as it were in a small vein, rising through the water. For handsomeness sake (because the working requireth some small time) it were good you hang the upper glass upon a nail. But as soon as there is gathered so much pure and unmixed water in the bottom of the lower glass as that the mouth of the upper glass dippeth into it, the motion ceaseth.

15. Let the upper glass be wine, and the lower water; there

[1] These experiments are taken from Porta's *Natural Magic*, xviii. 1. and 3.

[2] The wine and water are not separated from one another; all that takes place is that the water contained in the upper glass descends through the wine and water without perceptibly mixing with it, and settles at the bottom. The case is one of unstable equilibrium gradually becoming stable.

followeth no motion at all. Let the upper glass be water pure, the lower water coloured; or contrariwise; there followeth no motion at all. But it hath been tried, that though the mixture of wine and water in the lower glass be three parts water and but one wine, yet it doth not dead the motion. This separation of water and wine appeareth to be made by weight; for it must be of bodies of unequal weight, or else it worketh not; and the heavier body must ever be in the upper glass.[1] But then note withal, that the water being made pensile, and there being a great weight of water in the belly of the glass, sustained by a small pillar of water in the neck of the glass, it is that which setteth the motion on work: for water and wine in one glass, with long standing, will hardly sever.

16. This experiment would be extended from mixtures of several liquors, to simple bodies which consist of several similar parts. Try it therefore with brine or salt water, and fresh water; placing the salt water (which is the heavier) in the upper glass; and see whether the fresh will come above. Try it also with water thick sugared, and pure water; and see whether the water which cometh above will lose his sweetness: for which purpose it were good there were a little cock made in the belly of the upper glass.

Experiments in consort touching judicious and accurate infusions, both in liquors and air.

17. In bodies containing fine spirits which do easily dissipate, when you make infusions, the rule is, A short stay of the body in the liquor receiveth the spirit; and a longer stay confoundeth it; because it draweth forth the earthy part withal, which embaseth the finer. And therefore it is an error in physicians to rest simply upon the length of stay, for increasing the virtue. But if you will have the infusion strong, in those kinds of bodies which have fine spirits, your way is not to give longer time, but to repeat the infusion of the body oftener. Take violets, and infuse a good pugil of them in a quart of vinegar; let them stay three quarters of an hour, and take them forth; and refresh the infusion with like quantity of new violets, seven times; and it will make a vinegar so fresh of the flower, as if a twelvemonth after it be brought you in a saucer, you shall smell it before it come at you. Note, that it smelleth more perfectly of the flower a good while after than at first.

[1] Of course; as in the contrary case the equilibrium is stable.

18. This rule which we have given, is of singular use for the preparations of medicines and other infusions. As for example: the leaf of burrage hath an excellent spirit to repress the fuliginous vapour of dusky melancholy, and so to cure madness: but nevertheless, if the leaf be infused long, it yieldeth forth but a raw substance, of no virtue: therefore I suppose that if in the must of wine or wort of beer, while it worketh, before it be tunned, the burrage stay a small time, and be often changed with fresh; it will make a sovereign drink for melancholy passions. And the like I conceive of orange flowers.

19. Rhubarb hath manifestly in it parts of contrary operations: parts that purge, and parts that bind the body: and the first lie[1] looser, and the latter lie deeper: so that if you infuse rhubarb for an hour and crush it well, it will purge better, and bind the body less after the purging, than if it stood twenty-four hours. This is tried. But I conceive likewise, that by repeating the infusion of rhubarb several times, (as was said of violets,) letting each stay in but a small time, you may make it as strong a purging medicine as scammony. And it is not a small thing won in physic, if you can make rhubarb, and other medicines that are benedict, as strong purgers as those that are not without some malignity.

20. Purging medicines, for the most part, have their purgative virtue in a fine spirit; as appeareth by that they endure not boiling without much loss of virtue. And therefore it is of good use in physic, if you can retain the purging virtue, and take away the unpleasant taste of the purger; which it is like you may do, by this course of infusing oft, with little stay. For it is probable that the horrible and odious taste is the grosser part.[2]

21. Generally, the working by infusions is gross and blind, except you first try the issuing of the several parts of the body, which of them issue more speedily, and which more slowly; and so by apportioning the time, can take and leave that quality which you desire. This to know, there be two ways; the one to try what long stay and what short stay worketh, as hath been said; the other to try in order the succeeding infusions of one and the same body, successively, in several liquors. As for example; take orange-pills, or rosemary, or cinnamon, or

[1] *Lay* in the original, in both places. — *J. S.*
[2] *Is in the grosser part.* Ed. 1635. — *J. S.*

what you will; and let them infuse half an hour in water; then take them out, and infuse them again in other water; and so the third time: and then taste and consider the first water, the second, and the third; and you will find them differing, not only in strength and weakness, but otherwise in taste or odour; for it may be the first water will have more of the scent, as more fragrant; and the second more of the taste, as more bitter or biting, &c.

22. Infusions in air (for so we may well call odours) have the same diversities with infusions in water; in that the several odours (which are in one flower or other body) issue at several times; some earlier, some later. So we find that violets, woodbines, strawberries, yield a pleasing scent, that cometh forth first; but soon after an ill scent, quite differing from the former; which is caused not so much by mellowing, as by the late issuing of the grosser spirit.

23. As we may desire to extract the finest spirits in some cases, so we may desire also to discharge them (as hurtful) in some other. So wine burnt, by reason of the evaporating of the finer spirit, inflameth less, and is best in agues: opium leeseth some of his poisonous quality, if it be vapoured out, mingled with spirit of wine, or the like: sean loseth somewhat of his windiness by decocting; and (generally) subtile or windy spirits are taken off by incension or evaporation. And even in infusions in things that are of too high a spirit, you were better pour off the first infusion, after a small time, and use the latter.

Experiment solitary touching the appetite of continuation in liquids.

24. Bubbles are in the form of an hemisphere; air within, and a little skin of water without: and it seemeth somewhat strange, that the air should rise so swiftly while it is in the water; and when it cometh to the top, should be stayed by so weak a cover as that of the bubble is. But as for the swift ascent of the air, while it is under the water, that is a motion of percussion from the water; which itself descending driveth up the air; and no motion of levity in the air. And this Democritus called *motus plagæ*.[1] In this common experiment,

[1] "Declinat, inquit, atomus. Primum cur? aliam quandam vim motus habebunt a Democrito impulsionis, quam plagam ille appellat."—*Cicero, De Fato*, c. 20. It is difficult to determine whether this notion of "plaga" involved the conception of

the cause of the inclosure of the bubble is, for that the appetite to resist separation or discontinuance (which in solid bodies is strong) is also in liquors, though fainter and weaker; as we see in this of the bubble: we see it also in little glasses of spittle that children make of rushes; and in castles of bubbles, which they make by blowing into water, having obtained a little degree of tenacity by mixture of soap: we see it also in the stillicides of water, which, if there be water enough to follow, will draw themselves into a small thread, because they will not discontinue; but if there be no remedy, then they cast themselves into round drops; which is the figure that saveth the body most from discontinuance: the same reason is of the roundness of the bubble, as well for the skin of water, as for the air within; for the air likewise avoideth discontinuance; and therefore casteth itself into a round figure. And for the stop and arrest of the air a little while, it sheweth that the air of itself hath little or no appetite of ascending.

Experiment solitary touching the making of artificial springs.

25. The rejection which I continually use of experiments (though it appeareth not) is infinite; but yet if an experiment be probable in the work, and of great use, I receive it, but deliver it as doubtful. It was reported by a sober man, that an artificial spring may be made thus. Find out a hanging ground, where there is a good quick fall of rain-water. Lay a half-trough of stone, of a good length, three or four foot deep within the same ground; with one end upon the high ground, the other upon the low. Cover the trough with brakes a good thickness, and cast sand upon the top of the brakes. You shall see (saith he) that after some showers are past, the lower end of the trough will run like a spring of water: which is no marvel, if it hold while the rain-water lasteth; but he said it would continue long time after the rain is past: as if the water did multiply itself upon the air, by the help of the coldness and condensation of the earth, and the consort of the first water.

Experiment solitary touching the venomous quality of man's flesh.

26. The French (which put off the name of the French

a mutual action between the atoms. See Mullach. *Democrit. Abder. Oper. Frag.* p. 384.

disease unto the name of the disease of Naples) do rēport, that at the siege of Naples there were certain wicked merchants that barrelled up man's flesh (of some that had been lately slain in Barbary) and sold it for tunney; and that upon that foul and high nourishment was the original of that disease.[1] Which may well be; for that it is certain that the cannibals in the West Indies eat man's flesh; and the West Indies were full of the pocks when they were first discovered; and at this day the mortalest poisons practised by the West Indians have some mixture of the blood or fat or flesh of man; and divers witches and sorceresses, as well amongst the heathen as amongst the christians, have fed upon man's flesh, to aid (as it seemeth) their imagination with high and foul vapours.

Experiment solitary touching the version and transmutation of air into water.

27. It seemeth that there be these ways (in likelihood) of version of vapours or air into water and moisture. The first is cold; which doth manifestly condense; as we see in the contracting of the air in the weather-glass; whereby it is a degree nearer to water. We see it also in the generation of springs, which the ancients thought (very probably) to be made by the version of air into water, holpen by the rest which the air hath in those parts; whereby it cannot dissipate[2]; and by the coldness of rocks; for there springs are chiefly generated. We see it also in the effects of the cold of the middle region (as they call it) of the air; which produceth dews and rains. And the experiment of turning water into ice, by snow, nitre, and salt (whereof we shall speak hereafter) would be transferred to the turning of air into water. The second way is by compression; as in stillatories, where the vapour is turned back upon itself by the encounter of the sides of the stillatory; and in the dew upon the covers of boiling pots; and in the dew towards rain, upon marble and wainscot. But this is like to do no great effect; except it be upon vapours and gross air, that are already very near in degree to water. The third is that which may be searched into, but doth not yet appear; which

[1] This story is told in Sandys's *Travels*, p. 186. (7th edition). Monardes, quoted by Kapmannis, ascribes the disease to the bad food to which the army was reduced; but does not mention the use of human flesh. See Kapmannis, Ensáyos.

[2] Arist. Meteor. i. 13.

is, by mingling of moist vapours with air, and trying if they will not bring a return of more water than the water was at first: for if so, that increase is a version of the air. Therefore put water into the bottom of a stillatory, with the neb stopped; weigh the water first; hang in the middle of the stillatory a large sponge; and see what quantity of water you can crush out of it; and what it is more or less, compared with the water spent: for you must understand, that if any version can be wrought, it will be easiliest done in small pores: and that is the reason why we prescribe a sponge. The fourth way is probable also, though not appearing; which is, by receiving the air into the small pores of bodies: for (as hath been said) every thing in small quantity is more easy for version; and tangible bodies have no pleasure in the consort of air, but endeavour to subact it into a more dense body; but in entire bodies it is checked; because if the air should condense, there is nothing to succeed: therefore it must be in loose bodies, as sand and powder; which we see, if they lie close, of themselves gather moisture.

Experiment solitary touching the helps towards the beauty and good features of persons.

28. It is reported by some of the ancients[1], that whelps, or other creatures, if they be put young into such a cage or box as they cannot rise to their stature, but may increase in breadth or length, will grow accordingly as they can get room; which if it be true and feasible, and that the young creature so pressed and straitened[2] doth not thereupon die, it is a means to produce dwarf creatures, and in a very strange figure. This is certain, and noted long since, that the pressure or forming of parts of creatures, when they are very young, doth alter the shape not a little: as the stroking of the heads of infants between the hands was noted of old to make *Macrocephali;* which shape of the head at that time was esteemed.[3] And the raising gently of the bridge of the nose, doth prevent the deformity of a saddle nose. Which observation well weighed, may teach a means to make the persons of men and women, in many kinds, more comely and better featured than otherwise

[1] Namely by Aristotle, *Problem.* x. 14.
[2] *Straightened* in the original.—*J. S.*
[3] Hippocrates, De Aere Aquis et Locis. The same practice existed among many American tribes.

they would be, by the forming and shaping of them in their infancy: as by stroking up the calves of the legs, to keep them from falling down too low; and by stroking up the forehead, to keep them from being low-foreheaded. And it is a common practice to swathe infants, that they may grow more straight and better shaped: and we see young women, by wearing straight bodies, keep themselves from being gross and corpulent.

Experiment solitary touching the condensing of air, in such sort as it may put on weight and yield nourishment.

29. Onions, as they hang, will many of them shoot forth; and so will penny-royal; and so will an herb called orpin [1], with which they use in the country to trim their houses, binding it to a lath or stick, and setting it against a wall. We see it likewise, more especially, in the greater semper-vive, which will put out branches, two or three years: but it is true, that commonly they wrap the root in a cloth besmeared with oil, and renew it once in half a year. The like is reported by some of the ancients, of the stalks of lilies.[2] The cause is; for that these plants have a strong, dense, and succulent moisture, which is not apt to exhale; and so is able, from the old store, without drawing help from the earth, to suffice the sprouting of the plant: and this sprouting is chiefly in the late spring or early summer; which are the times of putting forth. We see also, that stumps of trees lying out of the ground, will put forth sprouts for a time. But it is a noble trial, and of very great consequence, to try whether these things, in the sprouting, do increase weight; which must be tried by weighing them before they be hanged up, and afterwards again when they are sprouted.[3] For if they increase not in weight, then it is no more but this; that what they send forth in the sprout they leese in some other part: but if they gather weight, then it is *magnale naturæ;* for it showeth that air may be made so to be condensed as to be converted into a dense body; whereas the race and period of all things, here above the earth, is to

[1] Sedum Telephium. The greater Sempervive, mentioned a little further on, is the great house-leek, or perhaps tree house-leek. See Gerard's Herbal. p. 510. (1636.)

[2] Pliny, xxi. 13.

[3] Bacon has here in a remarkable manner anticipated a celebrated experiment of Decandolle's, who showed that the cactus, which exhibits the phenomenon in question, actually loses in weight after severance from its root, though it will put out shoots of very considerable length. Compare Aristot. Prob. sect. xx. 21. and 26.

extenuate and turn things to be more pneumatical and rare; and not to be retrograde, from pneumatical to that which is dense. It sheweth also that air can nourish: which is another great matter of consequence. Note, that to try this, the experiment of the semper-vive must be made without oiling the cloth; for else, it may be the plant receiveth nourishment from the oil.[1]

Experiment solitary touching the commixture of flame and air, and the great force thereof.

30. Flame and air do not mingle, except it be in an instant, or in the vital spirits of vegetables and living creatures. In gunpowder, the force of it hath been ascribed to rarefaction of the earthy substance into flame; and thus far it is true: and then (forsooth) it is become another element, the form[2] whereof occupieth more place; and so of necessity followeth a dilatation; and therefore, lest two bodies should be in one place, there must needs also follow an expulsion of the pellet, or blowing up of the mine. But these are crude and ignorant speculations. For flame, if there were nothing else, except it were in a very great quantity, will be suffocate with any hard body, such as a pellet is, or the barrel of a gun; so as the flame would not expel the hard body, but the hard body would kill the flame, and not suffer it to kindle or spread. But the cause of this so potent a motion is the nitre (which we call otherwise saltpetre) which having in it a notable crude and windy spirit, first by the heat of the fire suddenly dilateth itself; (and we know that simple air, being preternaturally attenuated by heat, will make itself room, and break and blow up that which resisteth it); and secondly, when the nitre hath dilated itself, it bloweth abroad the flame, as an inward bellows. And therefore we see that brimstone, pitch, camphire, wild-fire, and divers other inflammable matters, though they burn cruelly and are hard to quench, yet they make no such fiery wind as gunpowder doth: and on the other side, we see that quicksilver (which is a most crude and watery body) heated and pent in, hath the like force with gunpowder. As for living creatures,

[1] The suggestions contained in this paragraph touching the nutrition of plants are exceedingly curious. In reality however the plant, though it loses by exhalation more in point of weight than it receives from the air, does actually assimilate the carbon existing in the carbonic acid of the latter; so that the test proposed is inconclusive.

[2] The word is used in its scholastic sense.

it is certain their vital spirits are a substance compounded of an airy and flamy matter; and though air and flame being free will not well mingle; yet bound in by a body that hath some fixing, they will. For that you may best see in those two bodies (which are their aliments) water and oil; for they likewise will not well mingle of themselves, but in the bodies of plants and living creatures they will. It is no marvel therefore, that a small quantity of spirits, in the cells of the brain and canals of the sinews, are able to move the whole body (which is of so great mass), both with so great force, as in wrestling, leaping, and with so great swiftness, as in playing division upon the lute. Such is the force of these two natures, air and flame, when they incorporate.

Experiment solitary touching the secret nature of flame.[1]

31. Take a small wax candle, and put it in a socket of brass or iron; then set it upright in a porringer full of spirit of wine heated; then set both the candle and spirit of wine on fire, and you shall see the flame of the candle open itself, and become four or five times bigger than otherwise it would have been; and appear in figure globular, and not in pyramis. You shall see also, that the inward flame of the candle keepeth colour, and doth not wax any whit blue towards the colour of the outward flame of the spirit of wine. This is a noble instance; wherein two things are most remarkable: the one, that one flame within another quencheth not; but is a fixed body, and continueth as air or water do. And therefore flame would still ascend upwards in one greatness, if it were not quenched on the sides: and the greater the flame is at the bottom, the higher is the rise. The other, that flame doth not mingle with flame, as air doth with air, or water with water, but only remaineth contiguous; as it cometh to pass betwixt consisting bodies. It appeareth also that the form of a pyramis in flame, which we usually see, is merely by accident, and that the air about, by quenching the sides of the flame, crusheth it, and extenuateth it into that form; for of itself it would be round; and therefore smoke is in the figure of a pyramis reversed; for the air quencheth the flame and receiveth the smoke. Note

[1] The explanation of this experiment is simply that in impure air flames increase in size because the heated vapour of which they are composed diffuses itself before it meets with sufficient oxygen for complete combustion.

also, that the flame of the candle, within the flame of the spirit of wine, is troubled; and doth not only open and move upwards, but moveth waving, and to and fro; as if flame of his own nature (if it were not quenched) would roll and turn, as well as move upwards. By all which it should seem that the celestial bodies (most of them) are true fires or flames, as the Stoics held; more fine (perhaps) and rarified than our flame is. For they are all globular and determinate; they have rotation; and they have the colour and splendour of flame: so that flame above is durable, and consistent, and in his natural place; but with us it is a stranger, and momentany, and impure; like Vulcan that halted with his fall.

Experiment solitary touching the different force of flame in the midst and on the sides.

32. Take an arrow, and hold it in flame for the space of ten pulses; and when it cometh forth, you shall find those parts of the arrow which were on the outsides of the flame more burned, blacked, and turned almost into a coal, whereas that in the midst of the flame will be as if the fire had scarce touched it.[1] This is an instance of great consequence for the discovery of the nature of flame; and sheweth manifestly that flame burneth more violently towards the sides than in the midst; and, which is more, that heat or fire is not violent or furious but where it is checked and pent. And therefore the Peripatetics (howsoever their opinion of an element of fire above the air is justly exploded) in that point they acquit themselves well: for being opposed, that if there were a sphere of fire that encompassed the earth so near hand, it were impossible but all things should be burnt up; they answer, that the pure elemental fire, in his own place and not irritate, is but of a moderate heat.

Experiment solitary touching the decrease of the natural motion of gravity in great distance from the earth, or within some depth of the earth.

33. It is affirmed constantly by many, as an usual experiment, that a lump of ore in the bottom of a mine will be tumbled and stirred by two men's strength, which if you bring it to the top of the earth, will ask six men's strength at

[1] The real reason is, that the air has freer access to the external parts of the wood.

the least to stir it. It is a noble instance, and is fit to be tried to the full. For it is very probable that the motion of gravity worketh weakly both far from the earth and also within the earth: the former, because the appetite of union of dense bodies with the earth, in respect of the distance, is more dull: the latter, because the body hath in part attained his nature when it is some depth in the earth. For as for the moving to a *point* or place (which was the opinion of the ancients) it is a mere vanity.[1]

Experiment solitary touching the contraction of bodies in bulk, by the mixture of the more liquid body with the more solid.

34. It is strange how the ancients took up experiments upon credit, and yet did build great matters upon them. The observation of some of the best of them, delivered confidently, is, that a vessel filled with ashes will receive the like quantity of water that it would have done if it had been empty.[2] But this is utterly untrue; for the water will not go in by a fifth part. And I suppose that that fifth part is the difference of the lying close or open of the ashes; as we see that ashes alone, if they be hard pressed, will lie in less room; and so the ashes with air between lie looser, and with water closer. For I have not yet found certainly, that the water itself, by mixture of ashes or dust, will shrink or draw into less room.

Experiment solitary touching the making vines more fruitful.

35. It is reported of credit, that if you lay good store of kernels of grapes about the root of a vine, it will make the vine come earlier and prosper better. It may be tried with other kernels laid about the root of a plant of the same kind; as figs, kernels of apples, &c. The cause may be, for that the kernels draw out of the earth juice fit to nourish the tree, as those that would be trees of themselves, though there were no root; but the root being of greater strength, robbeth and

[1] Bodies weigh less at the bottom of a mine than on the earth's surface, though of course the difference is not so great as Bacon supposed. The explanation is, that the shell external to the body exerts no attraction on it, and the body may therefore be conceived of, as lying on the surface of a smaller ellipsoid. This at least would be the case if the shell were perfectly homogeneous.

[2] Arist. Prob. xxv. 8. It has been found by Messrs. Playfair and Joule that the solution of many salts in water, *e. g.* of alum, increases the volume of the water simply by that of the water of crystallisation they contain; which is a curious approximation to Aristotle's notion.

devoureth the nourishment, when they have drawn it; as great fishes devour little.

Experiments in consort touching purging medicines.

36. The operation of purging medicines, and the causes thereof, have been thought to be a great secret; and so according to the slothful manner of men, it is referred to a hidden propriety, a specifical virtue, and a fourth quality[1], and the like shifts of ignorance. The causes of purging are divers: all plain and perspicuous, and throughly maintained by experience. The first is, that whatsoever cannot be overcome and digested by the stomach, is by the stomach either put up by vomit, or put down to the guts; and by that motion of expulsion in the stomach and guts, other parts of the body (as the orifices of the veins, and the like) are moved to expel by consent. For nothing is more frequent than motion of consent in the body of man. This surcharge of the stomach is caused either by the quality of the medicine, or by the quantity. The qualities are three: extreme bitter, as in aloes, coloquintida, &c.; loathsome and of horrible taste, as in agaric, black hellebore, &c.; and of secret malignity and disagreement towards man's body, many times not appearing much in the taste; as in scammony, mechoacham[2], antimony, &c. And note well, that if there be any medicine that purgeth, and hath neither of the first two manifest qualities, it is to be held suspected as a kind of poison; for that it worketh either by corrosion, or by a secret malignity and enmity to nature; and therefore such medicines are warily to be prepared and used. The quantity of that which is taken doth also cause purging; as we see in a great quantity of new milk from the cow; yea, and a great quantity of meat; for surfeits many times turn to purges, both upwards and downwards. Therefore we see generally, that the working of purging medicines cometh two or three hours after the medicines taken; for that the stomach

[1] That is, an occult quality not explicable by the combination of the primary qualities of the elements of which the body is composed. Occult qualities are often called tertiary, but Bacon apparently supposes that tertiary qualities are those which result from combinations of the secondary, and therefore ultimately from the four primary or elementary qualities, namely hot, cold, moist, and dry.

[2] Mechoachan is the root of an American plant; it takes its name from the district of Mexico from which it is brought. See Frampton's *Joyful News out of the new found World*, (1577) p. 23. Frampton's work is only a translation of that of Nicolas Monardes, of which a Latin translation by Clusius was published in 1574. I have not seen the original work, which is in Spanish. The title of Clusius's translation is *De simplicibus medicam. ex occident. India delatis.*

first maketh a proof whether it can concoct them. And the like happeneth after surfeits, or milk in too great quantity.

37. A second cause is mordication of the orifices of the parts; especially of the mesentery veins; as it is seen that salt, or any such thing that is sharp and biting, put into the fundament, doth provoke the part to expel; and mustard provoketh sneezing; and any sharp thing to the eyes provoketh tears. And therefore we see that almost all purgers have a kind of twitching and vellication, besides the griping which cometh of wind. And if this mordication be in an over-high degree, it is little better than the corrosion of poison; and it cometh to pass sometimes in antimony, especially if it be given to bodies not replete with humours; for where humours abound, the humours save the parts.

38. The third cause is attraction: for I do not deny, but that purging medicines have in them a direct force of attraction; as drawing plaisters have in surgery: and we see sage or bettony bruised, sneezing-powder, and other powders or liquors (which the physicians call *errhines*) put into the nose, draw phlegm and water from the head; and so it is in apophlegmatisms and gargarisms, that draw the rheum down by the palate. And by this virtue, no doubt, some purgers draw more one humour, and some another, according to the opinion received: as rhubarb draweth choler; sean melancholy; agaric phlegm, &c. But yet (more or less) they draw promiscuously. And note also, that besides sympathy between the purger and the humour, there is also another cause why some medicines draw some humour more than another. And it is, for that some medicines work quicker than others: and they that draw quick, draw only the lighter and more fluid humours; they that draw slow, work upon the more tough and viscous humours. And therefore men must beware how they take rhubarb and the like, alone, familiarly; for it taketh only the lightest part of the humour away, and leaveth the mass of humours more obstinate. And the like may be said of wormwood, which is so much magnified.

39. The fourth cause is flatuosity: for wind stirred moveth to expel: and we find that (in effect) all purgers have in them a raw spirit or wind; which is the principal cause of tortion in the stomach and belly. And therefore purgers leese (most of them) the virtue, by decoction upon the fire; and for that cause are given chiefly in infusion, juice, or powder.

40. The fifth cause is compression or crushing; as when water is crushed out of a sponge; so we see that taking cold moveth looseness by contraction of the skin and outward parts; and so doth cold likewise cause rheums and defluxions from the head; and some astringent plaisters crush out purulent matter. This kind of operation is not found in many medicines. Myrobalanes have it; and it may be the barks of peaches: for this virtue requireth an astriction; but such an astriction as is not grateful to the body; (for a pleasing astriction doth rather bind in the humours than expel them): and therefore such astriction is found in things of an harsh[1] taste.

41. The sixth cause is lubrefaction and relaxation. As we see in medicines emollient; such as are milk, honey, mallows, lettuce, mercurial, pellitory of the wall, and others. There is also a secret virtue of relaxation in cold; for the heat of the body bindeth the parts and humours together, which cold relaxeth; as it is seen in urine, blood, pottage, or the like; which, if they be cold, break and dissolve. And by this kind of relaxation, fear looseneth the belly: because the heat retiring inwards towards the heart, the guts and other parts are relaxed; in the same manner as fear also causeth trembling in the sinews. And of this kind of purgers are some medicines made of mercury.

42. The seventh cause is abstersion; which is plainly a scouring off, or incision of the more viscous humours, and making the humours more fluid; and cutting between them and the part. As is found in nitrous water, which scoureth linen cloth (speedily) from the foulness. But this incision must be by a sharpness without astriction: which we find in salt, wormwood, oxymel, and the like.

43. There be medicines that move stools, and not urine; some other, urine and not stools. Those that purge by stool, are such as enter not at all, or little, into the mesentery veins; but either at the first are not digestible by the stomach, and therefore move immediately downwards to the guts; or else are afterwards rejected by the mesentery veins, and so turn likewise downwards to the guts; and of these two kinds are most purgers. But those that move urine, are such as are

[1] *Harrish* in the original, both here and in several other places; though not always. But I suppose it is only another way of spelling *harsh*. — *J. S.*

well digested of the stomach, and well received also of the mesentery veins; so they come as far as the liver, which sendeth urine to the bladder, as the whey of blood; and those medicines being opening and piercing, do fortify the operation of the liver, in sending down the wheyey part of the blood to the reins. For medicines urinative do not work by rejection and indigestion, as solutive do.

44. There be divers medicines which in greater quantity move stool, and in smaller urine: and so contrariwise, some that in greater quantity move urine, and in smaller stool. Of the former sort is rhubarb, and some others. The cause is, for that rhubarb is a medicine which the stomach in a small quantity doth digest and overcome (being not flatuous nor loathsome) and so sendeth it to the mesentery veins; and so being opening, it helpeth down urine: but in a greater quantity, the stomach cannot overcome it, and so it goeth to the guts. Pepper by some of the ancients is noted to be of the second sort; which being in small quantity, moveth wind in the stomach or guts, and so expelleth by stool; but being in greater quantity, dissipateth the wind; and itself getteth to the mesentery veins, and so to the liver and reins; where, by heating and opening, it sendeth down urine more plentifully.

Experim[redacted] consort touching meats and drinks that are most nourishing.

45. We have spoken of evacuating of the body; we will now speak something of the filling of it by restoratives in consumptions and emaciating diseases. In vegetables, there is one part that is more nourishing than another; as grains and roots nourish more than the leaves; insomuch as the order of the Foliatanes was put down by the pope, as finding leaves unable to nourish man's body.[1] Whether there be that difference in the flesh of living creatures, is not well inquired: as whether livers, and other entrails be not more nourishing than

[1] Some account of the austerities of the Feuillans has been given in a note on the *Novum Organum*, vol. i. p. 360. The notion that they attempted to live on leaves arose probably from a mistaken etymology. The Abbey of Feuillans existed as a Cistercian monastery long before the reform which made it the seat of a new order. The reason why human beings cannot live upon grass or leaves appears to be the proportion in which vegetable fibre (cellulose and lignose) is present in those parts of vegetables. Animals, as the solipedes and the ruminants, to whom such a diet is natural, are adapted by the organisation either of the stomach or of the intestines for the separation and rejection of the large proportion of innutritious matter contained in their food.

the outward flesh. We find that amongst the Romans, a goose's liver was a great delicacy; insomuch as they had artificial means to make it fair and great[1]; but whether it were more nourishing appeareth not. It is certain that marrow is more nourishing than fat. And I conceive that some decoction of bones and sinews, stamped and well strained, would be a very nourishing broth: we find also that Scotch skinck, (which is a pottage of strong nourishment) is made with the knees and sinews of beef, but long boiled: jelly also, which they use for a restorative, is chiefly made of knuckles of veal. The pulp that is within the crafish or crab, which they spice and butter, is more nourishing than the flesh of the crab or crafish. The yolks of eggs are clearly more nourishing than the whites. So that it should seem that the parts of living creatures that lie more inwards, nourish more than the outward flesh; except it be the brain: which the spirits prey too much upon, to leave it any great virtue of nourishing. It seemeth for the nourishing of aged men, or men in consumptions, some such thing should be devised as should be half chylus, before it be put into the stomach.

46. Take two large capons; parboil them upon a soft fire, by the space of an hour or more, till in effect all the blood be gone. Add in the decoction the pill of a sweet lemon, or a good part of the pill of a citron, and a little mace. Cut off the shanks and throw them away. Then with a good strong chopping-knife mince the two capons, bones and all, as small as ordinary minced meat; put them into a large neat boulter; then take a kilderkin, sweet and well seasoned, of four gallons of beer, of 8*s.* strength[2], new as it cometh from the tunning: make in the kilderkin a great bung-hole of purpose: then thrust into it the boulter (in which the capons are) drawn out in length; let it steep in it three days and three nights, the bung-hole open, to work; then close the bung-hole, and so let it continue a day and a half; then draw it into bottles, and you may drink it well after three days' bottling; and it will last six weeks (approved). It drinketh fresh, flowereth and

[1] Pliny, x. 27. The goose was fed on figs. Hence the phrase *jecur ficatum*, or simply *ficatum*, for liver so prepared; and hence, according to Diez and other etymologists, the French word *foie* for liver in general. The presence of sugar in the liver even of carnivorous animals is one of the most curious of recent physiological discoveries.

[2] Perhaps the eight-shilling strength means that the barrel, *i. e.* thirty-six gallons, cost eight shillings.

mantleth exceedingly; it drinketh not newish at all. It is an excellent drink for a consumption, to be drunk either alone or carded with some other beer. It quencheth thirst, and hath no whit of windiness. Note, that it is not possible that meat and bread, either in broths, or taken with drink, as is used, should get forth into the veins and outward parts so finely and easily, as when it is thus incorporate, and made almost a chylus aforehand.

47. Trial would be made of the like brew with potado roots, or burr roots, or the pith of artichokes[1], which are nourishing meats: it may be tried also with other flesh; as pheasant, partridge, young pork, pig, venison, especially of young deer, &c.

48. A mortress made with the brawn of capons, stamped and strained, and mingled, (after it is made) with like quantity (at the least) of almond butter, is an excellent meat to nourish those that are weak; better than blanc-manger, or jelly; and so is the cullice of cocks, boiled thick with the like mixture of almond butter; for the mortress or cullice, of itself, is more savoury and strong, and not so fit for nourishing of weak bodies; but the almonds, that are not of so high a taste as flesh, do excellently qualify it.

49. Indian maiz hath (of certain) an excellent spirit of nourishment; but it must be thoroughly boiled, and made into a maiz-cream like a barley-cream. I judge the same of rice, made into a cream; for rice is in Turkey, and other countries of the east, most fed upon; but it must be thoroughly boiled, in respect of the hardness of it: and also because otherwise it bindeth the body too much.[2]

50. Pistachoes, so they be good, and not musty, joined with almonds in almond milk, or made into a milk of themselves, like unto almond milk, but more green, are an excellent nourisher; but you shall do well to add a little ginger, scraped, because they are not without some subtile windiness.

51. Milk warm from the cow, is found to be a great nou-

[1] Compare *Hist. Vitæ et Mortis*, p. 189. § 24.; where *pulpæ artiplicis* are mentioned in conjunction with *radices potado* and *radices bardanæ*. The coincidence favours Mr. Ellis's conjecture that by *artiplex* Bacon meant *artichoke*. — *J. S.*

[2] It seems to be clear that both maize and rice, and especially the latter, are inferior with respect to nutritive power to most of the cerealia. Maize is said to be indigenous in America, and to have been brought from thence to Europe. Yet the culture of it in Italy is said to be older than the discovery of America. The introduction of it is ascribed to a brother of Conrad of Montferrat. V. Michaud's *Hist. des Croisades*. The principal value of maize as an article of diet consists in its being richer in oil than any other grain. Rice, on the other hand, is remarkably deficient in this respect.

risher, and a good remedy in consumptions: but then you must put into it, when you milk the cow, two little bags; the one of powder of mint, the other of powder of red roses; for they keep the milk somewhat from turning or crudling in the stomach; and put in sugar also, for the same cause, and partly for the taste's sake; but you must drink a good draught, that it may stay less time in the stomach, lest it crudle: and let the cup into which you milk the cow, be set in a greater cup of hot water, that you may take it warm. And cow-milk thus prepared, I judge to be better for a consumption than ass-milk, which (it is true) turneth not so easily, but it is a little harsh[1]; marry it is more proper for sharpness of urine, and exulceration of the bladder, and all manner of lenifying. Woman's milk likewise is prescribed, when all fail; but I commend it not; as being a little too near the juice of man's body, to be a good nourisher; except it be in infants, to whom it is natural.

52. Oil of sweet almonds, newly drawn, with sugar and a little spice, spread upon bread toasted, is an excellent nourisher; but then to keep the oil from frying in the stomach, you must drink a good draught of mild beer after it; and to keep it from relaxing the stomach too much, you must put in a little powder of cinnamon.

53. The yolks of eggs are of themselves so well prepared by nature for nourishment, as (so they be poached, or rear boiled) they need no other preparation or mixture; yet they may be taken also raw, when they are new laid, with Malmsey or sweet wine: you shall do well to put in some few slices of eryngium roots, and a little ambergrice; for by this means, besides the immediate faculty of nourishment, such drink will strengthen the back; so that it will not draw down the urine too fast; for too much urine doth always hinder nourishment.

54. Mincing of meat, as in pies and buttered minced meat, saveth the grinding of the teeth; and therefore (no doubt) it is more nourishing; especially in age, or to them that have weak teeth; but the butter is not so proper for weak bodies; and therefore it were good to moisten it with a little claret wine, pill of lemon or orange, cut small, sugar, and a very little cinnamon or nutmeg. As for chuets, which are likewise minced meat, instead of butter and fat, it were good to moisten them partly with cream or almond or pistacho milk, or barley or maiz

[1] *Harrish* in the original. —*J. S.*

cream; adding a little coriander seed and caraway seed, and a very little saffron. The more full handling of alimentation we reserve to the due place.

We have hitherto handled the *particulars* which yield best and easiest and plentifullest nourishment; and now we will speak of the best *means* of conveying and converting the nourishment.

55. The first means is to procure that the nourishment may not be robbed and drawn away; wherein that which we have already said is very material; to provide that the reins draw not too strongly an over-great part of the blood into urine. To this add that precept of Aristotle, that wine be forborne in all consumptions[1]; for that the spirits of the wine do prey upon the roscide juice of the body, and inter-common with the spirits of the body, and so deceive and rob them of their nourishment. And therefore if the consumption, growing from the weakness of the stomach, do force you to use wine, let it always be burnt, that the quicker spirits may evaporate; or, at the least, quenched with two little wedges of gold, six or seven times repeated. Add also this provision, that there be not too much expence of the nourishment, by exhaling and sweating; and therefore if the patient be apt to sweat, it must be gently restrained. But chiefly Hippocrates' rule is to be followed; who adviseth quite contrary to that which is in use: namely, that the linen or garment next the flesh be, in winter, dry and oft changed; and in summer seldom changed, and smeared over with oil[2]; for certain it is, that any substance that is fat, doth a little fill the pores of the body, and stay sweat in some degree. But the more cleanly way is, to have the linen smeared lightly over with oil of sweet almonds; and not to forbear shifting as oft as is fit.

56. The second means is, to send forth the nourishment into the parts more strongly; for which the working must be by strengthening of the stomach; and in this, because the stomach is chiefly comforted by wine and hot things, which otherwise hurt, it is good to resort to outward applications to

[1] Aristotle does not give any precept on the subject; but that he thought wine hurtful in consumptions may be inferred from the *Problems*, iii. 5. and 23.

[2] See Hippocrates, *De Salubri Diætâ*, but it does not seem clear that the rule of wearing in summer ἐλαιωλίνεα ἱμάτια is given as a general precept. Hippocrates seems to refer particularly to persons of a gross habit.

the stomach: wherein it hath been tried, that the quilts of roses, spices, mastic, wormwood, mint, &c., are not so helpful, as to take a cake of new bread and to bedew it with a little sack or alegant; and to dry it; and after it be dried a little before the fire, to put it within a clean napkin, and to lay it to the stomach; for it is certain, that all flour hath a potent virtue of astriction; insomuch as it hardeneth a piece of flesh or a flower that is laid in it: and therefore a bag quilted with bran is likewise very good; but it drieth somewhat too much, and therefore it must not lie long.

57. The third means (which may be a branch of the former) is to send forth the nourishment the better by sleep. For we see that bears, and other creatures that sleep in the winter, wax exceeding fat: and certain it is, (as it is commonly believed) that sleep doth nourish much; both for that the spirits do less spend the nourishment in sleep, than when living creatures are awake; and because (that which is to the present purpose) it helpeth to thrust out the nourishment into the parts. Therefore in aged men, and weak bodies, and such as abound not with choler, a short sleep after dinner doth help to nourish; for in such bodies there is no fear of an over-hasty digestion, which is the inconvenience of postmeridian sleeps. Sleep also in the morning, after the taking of somewhat of easy digestion, as milk from the cow, nourishing broth, or the like, doth further nourishment: but this would be done sitting upright, that the milk or broth may pass the more speedily to the bottom of the stomach.

58. The fourth means is, to provide that the parts themselves may draw to them the nourishment strongly. There is an excellent observation of Aristotle: that a great reason why plants (some of them) are of greater age than living creatures is, for that they yearly put forth new leaves and boughs: whereas living creatures put forth (after their period of growth) nothing that is young but hair and nails, which are excrements, and no parts.[1] And it is most certain, that whatsoever is young, doth draw nourishment better than that which is old; and then (that which is the mystery of that observation) young boughs and leaves calling the sap up to them, the same

[1] Aristot. De Long. et Brev. Vitæ, 6. It may be said that in vegetables the seat of vitality is constantly shifting, and that in this respect they differ from all but the lower forms of animal life.

nourisheth the body in the passage. And this we see notably proved also, in that the oft cutting or polling of hedges, trees, and herbs, doth conduce much to their lasting. Transfer therefore this observation to the helping of nourishment in living creatures: the noblest and principal use whereof is, for the prolongation of life; restoration of some degree of youth; and inteneration of the parts; for certain it is, that there are in living creatures parts that nourish and repair easily, and parts that nourish and repair hardly; and you must refresh and renew those that are easy to nourish, that the other may be refreshed and (as it were) drink in nourishment in the passage. Now we see that draught oxen, put into good pasture, recover the flesh of young beef; and men, after long emaciating diets, wax plump and fat, and almost new: so that you may surely conclude, that the frequent and wise use of those emaciating diets, and of purgings, and perhaps of some kind of bleeding, is a principal means of prolongation of life, and restoring some degree of youth: for as we have often said, death cometh upon living creatures like the torment of Mezentius:

> Mortua quinetiam jungebat corpora vivis,
> Componens manibusque manus, atque oribus ora.[1]

For the parts in man's body easily reparable (as spirits, blood, and flesh) die in the embracement of the parts hardly reparable (as bones, nerves, and membranes); and likewise some entrails (which they reckon amongst the spermatical parts) are hard to repair: though that division of spermatical and menstrual parts be but a conceit.[2] And this same observation also may be drawn to the present purpose of nourishing emaciated bodies: and therefore gentle frication draweth forth the nourishment, by making the parts a little hungry, and heating them; whereby they call forth nourishment the better. This frication I wish to be done in the morning. It is also best done by the hand, or a piece of scarlet wool, wet a little with oil of almonds, mingled with a small quantity of bay-salt or saffron. We see that the very currying of horses doth make them fat and in good liking.

[1] Æn. viii. 485.

[2] See Telesius, De Rer. Nat. vi 1. His doctrine is "albas exsanguesque animalis partes prius quam sanguineas efformari, et illas e masculino fœmineoque semine, has e fœmineo sanguine, ab uteri calore immutatis." In this as elsewhere he follows Galen. See the *De fœtuum formatione*, c. 2., of the latter, and compare his *De usu partium*, xiv. 11.

59. The fifth means is, to further the very act of assimilation of nourishment; which is done by some outward emollients, that make the parts more apt to assimilate. For which I have compounded an ointment of excellent odour, which I call Roman ointment; vide the receipt.[1] The use of it would be between sleeps; for in the latter sleep the parts assimilate chiefly.

Experiment solitary touching Filum Medicinale.

60. There be many medicines, which by themselves would do no cure, but perhaps hurt; but being applied in a certain order, one after another, do great cures. I have tried (myself) a remedy for the gout, which hath seldom failed, but driven it away in twenty-four hours' space; it is first to apply a poultice, of which vide the receipt; and then a bath or fomentation, of which vide the receipt; and then a plaister, vide the receipt.[2] The poultice relaxeth the pores, and maketh the humour apt to exhale. The fomentation calleth forth the humour by vapours; but yet, in regard of the way made by the poultice, draweth gently; and therefore draweth the humour out, and doth not draw more to it; for it is a gentle fomentation, and hath withal a mixture (though very little) of some stupefactive. The plaister is a moderate astringent plaister, which repelleth new humour from falling. The poultice alone

[1] This receipt is not given in any edition of the *Sylva Sylvarum* which I have seen, but there is one answering the description in Tenison's *Baconiana*, p. 173.; for which see the *Medical Remains* in the next volume. — *J. S.*

[2] These receipts do not appear to have been given in the original edition. They were inserted on a separate leaf at the end of the edition of 1635; but may be most conveniently introduced here. — *J. S.*

His Lordship's usual receipt for the gout, to which the sixtieth experiment hath reference, was this.

To be taken in this order.

1. *The poultice.*

R. Of manchet about three ounces, the crumb only, thin cut. Let it be boiled in milk till it grow to a pulp. Add in the end a dram and a half of the powder of red roses.

Of saffron ten grains. Of oil of roses an ounce. Let it be spread upon a linen cloth, and applied luke-warm; and continued for three hours space.

2. *The bath or fomentation.*

R. Of sage-leaves half an handful. Of the root of hemlock sliced six drams. Of briony-roots half an ounce. Of the leaves of red roses two pugils. Let them be boiled in a pottle of water, wherein steel hath been quenched, till the liquor come to a quart. After the straining, put in half an handful of bay-salt. Let it be used with scarlet cloth, or scarlet wool, dipped in the liquor hot, and so renewed seven times; all in the space of a quarter of an hour, or little more.

3. *The plaister.*

R. *Emplastrum diacalciteos*, as much as is sufficient for the part you mean to cover. Let it be dissolved with oil of roses, in such a consistence as will stick; and spread upon a piece of holland, and applied.

would make the part more soft and weak, and apter to take the defluxion and impression of the humour. The fomentation alone, if it were too weak, without way made by the poultice, would draw forth little; if too strong, it would draw to the part, as well as draw from it. The plaister alone, would pen the humour already contained in the part, and so exasperate it, as well as forbid new humour. Therefore they must be all taken in order, as is said. The poultice is to be laid to for two or three hours: the fomentation for a quarter of an hour, or somewhat better, being used hot, and seven or eight times repeated: the plaister to continue on still, till the part be well confirmed.

Experiment solitary touching cure by custom.

61. There is a secret way of cure (unpractised) by assuetude of that which in itself hurteth. Poisons have been made, by some, familiar, as hath been said.[1] Ordinary keepers of the sick of the plague are seldom infected. Enduring of tortures, by custom, hath been made more easy. The brooking of enormous quantity of meats, and so of wine or strong drink, hath been, by custom, made to be without surfeit or drunkenness. And generally diseases that are chronical, as coughs, phthisics, some kinds of palsies, lunacies, &c., are more dangerous at the first. Therefore a wise physician will consider whether a disease be incurable; or whether the just cure of it be not full of peril; and if he find it to be such, let him resort to palliation; and alleviate the symptom, without busying himself too much with the perfect cure: and many times (if the patient be indeed patient) that course will exceed all expectation. Likewise the patient himself may strive, by little and little, to overcome the symptom in the exacerbation, and so, by time, turn suffering into nature.

Experiment solitary touching cure by excess.[2]

62. Divers diseases, especially chronical (such as quartan agues), are sometimes cured by surfeit and excesses: as excess of meat, excess of drink, extraordinary fasting, extraordinary stirring, or lassitude, and the like. The cause is, for that diseases of continuance get an adventitious strength from custom, besides their material cause from the humours; so that

[1] As in the case of Mithridates, and in that of the attempt made to poison Alexander.
[2] Compare Aristot. Prob. i. 2.

the breaking of the custom doth leave them only to their first cause; which if it be anything weak will fall off. Besides such excesses do excite and spur nature, which thereupon rises more forcibly against the disease.

Experiment solitary touching cure by motion of consent.

63. There is in the body of man a great consent in the motion of the several parts. We see it is children's sport to prove whether they can rub upon their breast with one hand, and pat upon their forehead with another; and straightways they shall sometimes rub with both hands, or pat with both hands. We see that when the spirits that come to the nostrils expel a bad scent, the stomach is ready to expel by vomit. We find that in consumptions of the lungs, when nature cannot expel by cough, men fall into fluxes of the belly, and then they die. So in pestilent diseases, if they cannot be expelled by sweat, they fall likewise into looseness; and that is commonly mortal. Therefore physicians should ingeniously contrive, how by motions that are in their power, they may excite inward motions that are not in their power, by consent: as by the stench of feathers, or the like, they cure the rising of the mother.

Experiment solitary touching cure of diseases which are contrary to predisposition.

64. Hippocrates' aphorism, *in morbis minus*, is a good profound aphorism.[1] It importeth, that diseases contrary to the complexion, age, sex, season of the year, diet, &c., are more dangerous than those that are concurrent. A man would think it should be otherwise; for that when the accident of sickness and the natural disposition do second the one the other, the disease should be more forcible: and so (no doubt) it is, if you suppose like quantity of matter. But that which maketh good the aphorism is, because such diseases do shew a greater collection of matter, by that they are able to overcome those natural inclinations to the contrary. And therefore in diseases of that kind, let the physician apply himself more to purgation than to alteration; because the offence is in the quantity; and the qualities are rectified of themselves.

[1] "In morbis minus periclitantur quorum naturæ et ætati et habitui et tempori morbus magis affinis fuerit, quam hi quibus non affinis in aliquo horum existit."—*Hippocrates, Aph.* ii. 34.

Experiment solitary touching preparations before purging, and settling of the body afterward.

65. Physicians do wisely prescribe, that there be preparatives used before just purgations; for certain it is that purgers do many times great hurt, if the body be not accommodated both before and after the purging. The hurt that they do for want of preparation before purging, is by the sticking of the humours, and their not coming fair away; which causeth in the body great perturbations and ill accidents during the purging; and also the diminishing and dulling of the working of the medicine itself, that it purgeth not sufficiently. Therefore the work of preparation is double; to make the humours fluid and mature, and to make the passages more open: for those both help to make the humours pass readily. And for the former of these, syrups are most profitable; and for the latter, apozumes, or preparing broths; clysters also help, lest the medicine stop in the guts, and work gripingly. But it is true that bodies abounding with humours, and fat bodies, and open weather, are preparatives in themselves; because they make the humours more fluid. But let a physician beware how he purge after hard frosty weather, and in a lean body, without preparation. For the hurt that they may do after purging, it is caused by the lodging of some humours in ill places: for it is certain that there be humours, which somewhere placed in the body, are quiet and do little hurt; in other places (especially passages) do much mischief. Therefore it is good, after purging, to use apozumes and broths not so much opening as those used before purging; but abstersive and mundifying clysters also are good to conclude with, to draw away the reliques of the humours that may have descended to the lower region of the body.

Experiment solitary touching stanching of blood.

66. Blood is stanched divers ways. First, by astringents and repercussive medicines. Secondly, by drawing of the spirits and blood inwards; which is done by cold; as iron or a stone laid to the neck doth stanch the bleeding of the nose; also it hath been tried, that the testicles being put into sharp vinegar, hath made a sudden recess of the spirits, and stanched blood. Thirdly, by the recess of the blood by sympathy. So it hath been tried, that the part that bleedeth being thrust

into the body of a capon or sheep, new ript and bleeding, hath stanched blood: the blood, as it seemeth, sucking and drawing up, by similitude of substance, the blood it meeteth with, and so itself going back. Fourthly, by custom and time; so the Prince of Orange, in his first hurt by the Spanish boy, could find no means to stanch the blood either by medicine or ligament; but was fain to have the orifice of the wound stopped by men's thumbs, succeeding one another, for the space at the least of two days; and at the last the blood by custom only retired.[1] There is a fifth way also in use, to let blood in an adverse part, for a revulsion.

Experiment solitary touching change of aliments and medicines.

67. It helpeth, both in medicine and aliment, to change, and not to continue the same medicine and aliment still. The cause is, for that nature, by continual use of any thing, groweth to a satiety and dullness, either of appetite or working. And we see that assuetude of things hurtful doth make them leese their force to hurt; as poison, which with use some have brought themselves to brook. And therefore it is no marvel though things helpful, by custom, leese their force to help. I count intermission almost the same thing with change; for that that hath been intermitted is after a sort new.

Experiment solitary touching diets.

68. It is found by experience, that in diets of guaiacum, sarza, and the like, (especially if they be strict,) the patient is more troubled in the beginning than after continuance; which hath made some of the more delicate sort of patients give them over in the midst; supposing that if those diets trouble them so much at first, they shall not be able to endure them to the end. But the cause is, for that all those diets do dry up humours, rheums, and the like: and they cannot dry up until they have first attenuated; and while the humour is attenuated, it is more fluid than it was before, and troubleth the body a great deal more, until it be dried up and consumed. And therefore patients must expect a due time, and not check at them at the first.

[1] The Prince of Orange was shot through both cheeks at Antwerp in 1582. Bacon calls this his first hurt, because two years afterwards he was killed by Baltasar Gerard.

Experiments in consort touching the production of cold.

The producing of cold is a thing very worthy the inquisition; both for use and disclosure of causes. For heat and cold are nature's two hands, whereby she chiefly worketh; and heat we have in readiness, in respect of the fire; but for cold we must stay till it cometh, or seek it in deep caves or high mountains: and when all is done, we cannot obtain it in any great degree: for furnaces of fire are far hotter than a summer's sun; but vaults or hills are not much colder than a winter's frost.

69. The first means of producing cold is that which nature presenteth us withal: namely, the expiring of cold out of the inward parts of the earth in winter, when the sun hath no power to overcome it; the earth being (as hath been noted by some) *primum frigidum.* This hath been asserted as well by ancient as by modern philosophers. It was the tenet of Parmenides. It was the opinion of the author of the discourse in Plutarch (for I take it that book was not Plutarch's own) *De primo frigido.* It was the opinion of Telesius, who hath renewed the philosophy of Parmenides, and is the best of the novellists.

70. The second cause of cold is the contact of cold bodies; for cold is active and transitive into bodies adjacent, as well as heat: which is seen in those things that are touched with snow or cold water. And therefore, whosoever will be an inquirer into nature, let him resort to a conservatory of snow and ice, such as they use for delicacy to cool wine in summer: which is a poor and contemptible use, in respect of other uses that may be made of such conservatories.

71. The third cause is the primary nature of all tangible bodies; for it is well to be noted, that all things whatsoever (tangible) are of themselves cold; except they have an accessory heat by fire, life, or motion: for even the spirit of wine, or chemical oils, which are so hot in operation, are to the first touch cold; and air itself compressed and condensed a little by blowing is cold.

72. The fourth cause is the density of the body; for all dense bodies are colder than most other bodies; as metals, stone, glass; and they are longer in heating than softer bodies. And it is certain, that Earth, Dense, Tangible, hold all of the nature

of cold. The cause is, for that all matters tangible being cold, it must needs follow, that where the matter is most congregate the cold is the greater.

73. The fifth cause of cold, or rather of increase and vehemence of cold, is a quick spirit inclosed in a cold body: as will appear to any that shall attentively consider of nature in many instances. We see nitre (which hath a quick spirit) is cold; more cold to the tongue than a stone. So water is colder than oil, because it hath a quicker spirit; for all oil, though it hath the tangible parts better digested than water, yet hath it a duller spirit. So snow is colder than water, because it hath more spirit within it. So we see that salt put to ice (as in the producing of the artificial ice) increaseth the activity of cold. So some *insecta* which have spirit of life, as snakes and silk-worms, are to the touch cold. So quicksilver is the coldest of metals, because it is fullest of spirit.

74. The sixth cause of cold is the chasing and driving away of spirits, such as have some degree of heat: for the banishing of the heat must needs leave any body cold. This we see in the operation of opium and stupefactives upon the spirits of living creatures. And it were not amiss to try opium, by laying it upon the top of a weather-glass, to see whether it will contract the air. But I doubt it will not succeed; for besides that the virtue of opium will hardly penetrate through such a body as glass, I conceive that opium, and the like, make the spirits fly rather by malignity than by cold.

75. Seventhly, the same effect must follow upon the exhaling or drawing out of the warm spirits, that doth upon the flight of the spirits. There is an opinion, that the moon is magnetical of heat, as the sun is of cold and moisture: it were not amiss therefore to try it with warm waters; the one exposed to the beams of the moon; the other with some skreen betwixt the beams of the moon and the water; as we use to the sun for shade: and to see whether the former will cool sooner. And it were also good to inquire, what other means there may be to draw forth the exile heat which is in the air; for that may be a secret of great power to produce cold weather.[1]

[1] The most intense cold yet known is produced in Thillorier's experiment, by the sudden conversion into the gaseous state of liquid carbonic acid. It is so intense as to solidify a portion of the acid in a form resembling snow.

Experiments in consort touching the version and transmutation of air into water.

We have formerly set down the means of turning air into water, in the experiment 27. But because it is *magnale naturæ*, and tendeth to the subduing of a very great effect, and is also of manifold use, we will add some instances in consort that give light thereunto.

76. It is reported by some of the ancients, that sailors have used, every night, to hang fleeces of wool on the sides of their ships, the wool towards the water; and that they have crushed fresh water out of them in the morning, for their use.[1] And thus much we have tried, that a quantity of wool tied loose together, being let down into a deep well, and hanging in the middle some three fathom from the water for a night in the winter time, increased in weight (as I now remember) to a fifth part.

77. It is reported by one of the ancients, that in Lydia, near Pergamus, there were certain workmen in time of wars fled into caves; and the mouth of the caves being stopped by the enemies, they were famished. But long time after the dead bones were found; and some vessels which they had carried with them; and the vessels full of water; and that water thicker, and more towards ice, than common water[2]: which is a notable instance of condensation and induration by burial under earth (in caves) for long time; and of version also (as it should seem) of the air into water; if any of those vessels were empty. Try therefore a small bladder hung in snow, and the like in nitre, and the like in quicksilver; and if you find the bladders fallen or shrunk, you may be sure the air is condensed by the cold of those bodies; as it would be in a cave under earth.

78. It is reported of very good credit, that in the East Indies, if you set a tub of water open in a room where cloves are kept, it will be drawn dry in twenty-four hours; though it stand at some distance from the cloves. In the country, they use many times, in deceit, when their wool is new shorn, to set some pails of water by in the same room, to increase the weight of the wool. But it may be, that the heat of the wool remain-

[1] Pliny, xxxi. 37.

[2] Aristot. De Mirab. 52. But Aristotle, or rather the author of the treatise *De Mirab.*, does not speak of any change in the water, but only that the vessels and the bones of the workmen were petrified.

ing from the body of the sheep, or the heat gathered by the lying close of the wool, helpeth to draw the watery vapour; but that is nothing to the version.

79. It is reported also credibly, that wool new shorn, being laid casually upon a vessel of verjuice, after some time, hath drunk up a great part of the verjuice, though the vessel were whole without any flaw, and had not the bung-hole open. In this instance there is (upon the by) to be noted, the percolation or suing of the verjuice through the wood; for verjuice of itself would never have passed through the wood; so as it seemeth it must be first in a kind of vapour, before it pass.

80. It is especially to be noted, that the cause that doth facilitate the version of air into water, when the air is not in gross, but subtilly mingled with tangible bodies, is (as hath been partly touched before) for that tangible bodies have an antipathy with air; and if they find any liquid body that is more dense near them, they will draw it; and after they have drawn it, they will condense it more, and in effect incorporate it; for we see that a sponge, or wool, or sugar, or a woollen cloth, being put but in part in water or wine, will draw the liquor higher, and beyond the place where the water or wine cometh. We see also, that wood, lute-strings, and the like, do swell in moist seasons; as appeareth by the breaking of the strings, the hard turning of the pegs, and the hard drawing forth of boxes, and opening of wainscot doors: which is a kind of infusion; and is much like to an infusion in water, which will make wood to swell; as we see in the filling of the chops of bowls, by laying them in water. But for that part of these experiments which concerneth attraction, we will reserve it to the proper title of attraction.

81. There is also a version of air into water seen in the sweating of marbles and other stones; and of wainscot before and in moist weather. This must be, either by some moisture the body yieldeth, or else by the moist air thickened against the hard body. But it is plain that it is the latter; for that we see wood painted with oil-colour will sooner gather drops in a moist night, than wood alone, which is caused by the smoothness and closeness, which letteth in no part of the vapour, and so turneth it back, and thickeneth it into dew. We see also, that breathing upon a glass or smooth body giveth a dew; and in frosty mornings (such as we call rime frosts) you shall find

drops of dew upon the inside of glass-windows; and the frost itself upon the ground is but a version or condensation of the moist vapours of the night into a watery substance: dews likewise, and rain, are but the returns of moist vapours condensed; the dew, by the cold only of the sun's departure, which is the gentler cold; rains, by the cold of that which they call the middle region of the air; which is the more violent cold.

82. It is very probable (as hath been touched) that that which will turn water into ice, will likewise turn air some degree nearer unto water. Therefore try the experiment of the artificial turning water into ice[1] (whereof we shall speak in another place) with air in place of water, and the ice about it. And although it be a greater alteration to turn air into water, than water into ice; yet there is this hope, that by continuing the air longer time, the effect will follow; for that artifical conversion of water into ice, is the work of a few hours; and this of air may be tried by a month's space, or the like.

Experiments in consort touching induration of bodies.

Induration, or lapidification, of substances more soft, is likewise another degree of condensation, and is a great alteration in nature. The effecting and accelerating thereof is very worthy to be inquired. It is effected by three means. The first is by cold, whose property is to condense and constipate, as hath been said. The second is by heat; which is not proper, but by consequence; for the heat doth attenuate; and by attenuation doth send forth the spirit and moister part of a body; and upon that, the more gross of the tangible parts do contract and serre themselves together; both to avoid *vacuum* (as they call it); and also to munite themselves against the force of the fire which they have suffered. And the third is by assimilation; when a hard body assimilateth a soft, being contiguous to it.

The examples of induration, taking them promiscuously, are many: as the generation of stones within the earth, which at the first are but rude earth or clay; and so of minerals, which come (no doubt) at first of juices concrete, which afterwards indurate: and so of porcelain, which is an

[1] Bacon here, as elsewhere, refers to the experiment performed by Drebbel in the presence of James I.

artificial cement, buried in the earth a long time; and so the making of brick and tile; also the making of glass of a certain sand and brake-roots, and some other matters; also the exudations of rock-diamonds and crystal, which harden with time; also the induration of bead-amber, which at first is a soft substance; as appeareth by the flies and spiders which are found in it; and many more; but we will speak of them distinctly.

83. For indurations by cold, there be few trials of it; for we have no strong or intense cold here on the surface of the earth, so near the beams of the sun and the heavens. The likeliest trial is by snow and ice; for as snow and ice, especially being holpen and their cold activated by nitre or salt, will turn water into ice, and that in a few hours; so it may be, it will turn wood or stiff clay into stone, in longer time. Put therefore into a conserving pit of snow and ice (adding some quantity of salt and nitre) a piece of wood, or a piece of tough clay, and let it lie a month or more.

84. Another trial is by metalline waters, which have virtual cold in them. Put therefore wood or clay into smith's water, or other metalline water; and try whether it will not harden in some reasonable time. But I understand it of metalline waters that come by washing or quenching, and not of strong waters that come by dissolution; for they are too corrosive to consolidate.

85. It is already found that there are some natural spring-waters, that will inlapidate wood; so as you shall see one piece of wood, whereof the part above the water shall continue wood, and the part under the water shall be turned into a kind of gravelly stone. It is likely those waters are of some metalline mixture; but there would be more particular inquiry made of them. It is certain, that an egg was found, having lien many years in the bottom of a moat, where the earth had somewhat overgrown it; and this egg was come to the hardness of a stone, and had the colours of the white and yolk perfect, and the shell shining in small grains like sugar or alabaster.

86. Another experience there is of induration by cold, which is already found; which is, that metals themselves are hardened by often heating and quenching in cold water: for cold ever worketh most potently upon heat precedent.

87. For induration by heat, it must be considered, that heat, by the exhaling of the moister parts, doth either harden the body; as in bricks, tiles, &c.; or if the heat be more fierce, maketh the grosser part itself run and melt; as in the making of ordinary glass; and in the vitrification of earth (as we see in the inner parts of furnaces), and in the vitrification of brick, and of metals. And in the former of these, which is the hardening by baking without melting, the heat hath these degrees; first, it indurateth, and then maketh fragile, and lastly it doth incinerate and calcinate.

88. But if you desire to make an induration with toughness and less fragility, a middle way would be taken, which is that which Aristotle hath well noted[1], but would be thoroughly verified. It is to decoct bodies in water for two or three days. But they must be such bodies into which the water will not enter; as stone and metal. For if they be bodies into which the water will enter, then long seething will rather soften than indurate them; as hath been tried in eggs, &c. Therefore softer bodies must be put into bottles; and the bottles hung into water seething, with the mouths open, above the water, that no water may get in: for by this means the virtual heat of the water will enter; and such a heat as will not make the body adust or fragile; but the substance of the water will be shut out. This experiment we made; and it sorted thus. It was tried with a piece of free-stone, and with pewter, put into the water at large. The free-stone, we found, received in some water; for it was softer and easier to scrape than a piece of the same stone kept dry. But the pewter, into which no water could enter, became more white, and liker to silver, and less flexible by much. There were also put into an earthen bottle, placed as before, a good pellet of clay, a piece of cheese, a piece of chalk, and a piece of free-stone. The clay came forth almost of the hardness of stone: the cheese likewise very hard, and not well to be cut; the chalk and the free-stone much harder than they were. The colour of the clay inclined not a whit to the colour of brick, but rather to white, as in ordinary drying by the sun. Note, that all the former trials were made by a boiling upon a good hot fire, renewing the water as it consumed with other hot water; but the boiling was but for twelve hours only: and it is like that the experiment would have been

[1] I have not been able to find the passage here referred to.

more effectual, if the boiling had been for two or three days, as we prescribed before.

89. As touching assimilation (for there is a degree of assimilation even in inanimate bodies), we see examples of it in some stones in clay-grounds, lying near to the top of the earth, where pebble is; in which you may manifestly see divers pebbles gathered together, and a crust of cement or stone between them as hard as the pebbles themselves; and it were good to make a trial of purpose, by taking clay, and putting in it divers pebble-stones, thick set, to see whether in continuance of time it will not be harder than other clay of the same lump, in which no pebbles are set.[1] We see also in ruins of old walls, especially towards the bottom, the mortar will become as hard as the brick; we see also, that the wood on the sides of vessels of wine, gathereth a crust of tartar, harder than the wood itself; and scales likewise grow to the teeth, harder than the teeth themselves.

90. Most of all, induration by assimilation appeareth in the bodies of trees and living creatures: for no nourishment that the tree receiveth, or that the living creature receiveth, is so hard as wood, bone, or horn, &c., but is indurated after by assimilation.

Experiment solitary touching the version of water into air.

91. The eye of the understanding is like the eye of the sense; for as you may see great objects through small crannies or levels, so you may see great axioms of nature through small and contemptible instances. The speedy depredation of air upon watery moisture, and version of the same into air, appeareth in nothing more visible than in the sudden discharge or vanishing of a little cloud of breath or vapour from glass, or the blade of a sword, or any such polished body; such as doth not at all detain or imbibe the moisture; for the mistiness scattereth and breaketh up suddenly. But the like cloud, if it were oily or fatty, will not discharge; not because it sticketh faster, but because air preyeth upon water, and flame and fire upon oil; and therefore to take out a spot of grease, they use a

[1] In the museum of the University of Liége I was shown a cannon ball, originally (it was affirmed) iron, which had been converted into stone by the influence of the sandstone in which it was imbedded. It appeared to me that the ball was stone *ab origine*, and that the sandstone in which it lay being ferruginous had suggested the idea of the metamorphosis.

coal upon brown paper; because fire worketh upon grease or oil, as air doth upon water. And we see paper oiled, or wood oiled, or the like, last long moist; but wet with water, dry or putrify sooner. The cause is, for that air meddleth little with the moisture of oil.

Experiment solitary touching the force of union.

92. There is an admirable demonstration in the same trifling instance of the little cloud upon glass or gems or blades of swords, of the force of union, even in the least quantities and weakest bodies, how much it conduceth to preservation of the present form, and the resisting of a new. For mark well the discharge of that cloud; and you shall see it ever break up, first in the skirts, and last in the midst. We see likewise, that much water draweth forth the juice of the body infused; but little water is imbibed by the body: and this is a principal cause why, in operation upon bodies for their version or alteration, the trial in great quantities doth not answer the trial in small, and so deceiveth many; for that (I say) the greater body resisteth more any alteration of form, and requireth far greater strength in the active body that should subdue it.

Experiment solitary touching the producing of feathers and hairs of divers colours.

93. We have spoken before, in the fifth instance, of the cause of orient colours in birds; which is by the fineness of the strainer; we will now endeavour to reduce the same axiom to a work. For this writing of our *Sylva Sylvarum* is (to speak properly) not natural history, but a high kind of natural magic. For it is not a description only of nature, but a breaking of nature into great and strange works. Try therefore the anointing over of pigeons, or other birds, when they are but in their down; or of whelps, cutting their hair as short as may be; or of some other beast; with some ointment that is not hurtful to the flesh, and that will harden and stick very close; and see whether it will not alter the colours of the feathers or hair. It is received, that the pulling off the first feathers of birds clean, will make the new come forth white: and it is certain that white is a penurious colour, and where moisture is scant. So blue violets and other flowers, if they be starved, turn pale and white; birds and horses, by age or scars, turn

white; and the hoar hairs of men come by the same reason. And therefore in birds, it is very likely that the feathers that come first will be many times of divers colours, according to the nature of the bird; for that the skin is more porous; but when the skin is more shut and close, the feathers will come white. This is a good experiment, not only for the producing of birds and beasts of strange colours, but also for the disclosure of the nature of colours themselves: which of them require a finer porosity, and which a grosser.

Experiment solitary touching the nourishment of living creatures before they be brought forth.

94. It is a work of providence, that hath been truly observed by some, that the yolk of the egg conduceth little to the generation of the bird, but only to the nourishment of the same [1]; for if a chicken be opened when it is new hatched, you shall find much of the yolk remaining.[2] And it is needful that birds, that are shaped without the female's womb, have in the egg as well matter of nourishment as matter of generation for the body. For after the egg is laid, and severed from the body of the hen, it hath no more nourishment from the hen, but only a quickening heat when she sitteth. But beasts and men need not the matter of nourishment within themselves, because they are shaped within the womb of the female, and are nourished continually from her body.

Experiments in consort touching sympathy and antipathy for medicinal use.

95. It is an inveterate and received opinion, that cantharides applied to any part of the body touch the bladder and exulcerate it, if they stay on long. It is likewise received, that a kind of stone, which they bring out of the West Indies, hath a peculiar force to move gravel, and to dissolve the stone; insomuch as laid but to the wrist, it hath so forcibly sent down gravel, as men have been glad to remove it, it was so violent.[3]

[1] See Aristot. De Gen. Animal. iii. 2.

[2] According to Vicq d'Azyr, the pedicule of the yolk remains permanently, and something of the yolk itself may be traced until the 12th or 13th day after the chicken is hatched. The opinion that the yolk contributes to the nutriment of the chicken appears to be well founded, as chickens from which it had been removed died with symptoms of atrophy.

[3] Monardes in Frampton's translation speaks thus of the efficacy of this stone. "A gentleman whiche had one of them here, the best of them that I have seen, hauying

96. It is received and confirmed by daily experience, that the soles of the feet have great affinity with the head and the mouth of the stomach; as we see, going wet-shod, to those that use it not, affecteth both: applications of hot powders to the feet attenuate first, and after dry the rheum; and therefore a physician that would be mystical, prescribeth for the cure of the rheum, that a man should walk continually upon a camomile alley; meaning, that he should put camomile within his socks. Likewise pigeons bleeding, applied to the soles of the feet, ease the head; and soporiferous medicines applied unto them, provoke sleep.

97. It seemeth that as the feet have a sympathy with the head, so the wrists and hands have a sympathy with the heart; we see the affects and passions of the heart and spirits are notably disclosed by the pulse: and it is often tried, that juices of stock-gilly-flowers, rose-campion, garlick, and other things, applied to the wrists and renewed, have cured long agues. And I conceive that washing with certain liquors the palms of the hands doth much good: and they do well in heats of agues, to hold in the hands eggs of alabaster and balls of crystal.

Of these things we shall speak more, when we handle the title of sympathy and antipathy in the proper place.

Experiment solitary touching the secret processes of nature.

98. The knowledge of man (hitherto) hath been determined by the view or sight; so that whatsoever is invisible, either in respect of the fineness of the body itself, or the smallness of the parts, or of the subtilty of the motion, is little inquired. And yet these be the things that govern nature principally; and without which you cannot make any true analysis and indication of the proceedings of nature. The spirits or pneumaticals, that are in all tangible bodies, are scarce known. Sometimes they take them for *vacuum*; whereas they are the most active of bodies. Sometimes they take them for air; from which they differ exceedingly, as much as wine from water, and as wood from earth. Sometimes they will have them to be natural heat, or a portion of the element of fire; whereas some of them are crude and cold. And sometimes they

put it to his arme, he dooeth make hym to expell and caste out much sande, that many tymes he doeth take it awaie, for that he thinketh that it dooeth hurte hym for to put out so muche, and in takyng it awaie he ceaseth to caste any from hym," &c.—*Joyfull Newes out of the newe founde Worlde*, fol. 19.

will have them to be the virtues and qualities of the tangible parts which they see; whereas they are things by themselves. And then, when they come to plants and living creatures, they call them souls. And such superficial speculations they have; like prospectives, that shew things inward, when they are but paintings. Neither is this a question of words, but infinitely material in nature. For spirits are nothing else but a natural body, rarified to a proportion, and included in the tangible parts of bodies, as in an integument. And they be no less differing one from the other than the dense or tangible parts; and they are in all tangible bodies whatsoever, more or less; and they are never (almost) at rest; and from them and their motions principally proceed arefaction, colliquation, concoction, maturation, putrefaction, vivification, and most of the effects of nature; for, as we have figured them in our *Sapientia Veterum*, in the fable of Proserpina, you shall in the infernal regiment hear little doings of Pluto, but most of Proserpina: for tangible parts in bodies are stupid things; and the spirits do (in effect) all. As for the differences of tangible parts in bodies, the industry of the chemists hath given some light, in discerning by their separations the oily, crude, pure, impure, fine, gross parts of bodies, and the like. And the physicians are content to acknowledge that herbs and drugs have divers parts; as that opium hath a stupefacting part, and a heating part; the one moving sleep, the other a sweat following; and that rhubarb hath purging parts, and astringent parts, &c. But this whole inquisition is weakly and negligently handled. And for the more subtile differences of the minute parts, and the posture of them in the body, (which also hath great effects,) they are not at all touched: as for the motions of the minute parts of bodies, which do so great effects, they have not been observed at all; because they are invisible, and incur not to the eye; but yet they are to be deprehended by experience: as Democritus said well, when they charged him to hold that the world was made of such little motes as were seen in the sun: *Atomus*, saith he, *necessitate rationis et experientiæ esse convincitur; atomum enim nemo unquam vidit.*[1] And therefore the tumult in

[1] There is no doubt but that Democritus affirmed that the atom is cognisable by the mind only, and nowise by the senses. See among other passages Sextus Empiricus *Adver. Logicos*, ii. 6. On the other hand, he certainly compared his atoms to motes seen in the sunbeams, probably because the latter, though known to exist, are for the most part invisible. See Arist. De Anim. i. 2.

the parts of solid bodies when they are compressed, which is the cause of all flight of bodies through the air, and of other mechanical motions, (as hath been partly touched before, and shall be thoroughly handled in due place,) is not seen at all. But nevertheless, if you know it not, or inquire it not attentively and diligently, you shall never be able to discern, and much less to produce, a number of mechanical motions. Again, as to the motions corporal within the inclosures of bodies, whereby the effects (which were mentioned before) pass between the spirits and the tangible parts, (which are arefaction, colliquation, concoction, maturation, &c.,) they are not at all handled. But they are put off by the names of virtues, and natures, and actions, and passions, and such other logical words.

Experiment solitary touching the power of heat.

99. It is certain that of all powers in nature heat is the chief; both in the frame of nature, and in the works of art. Certain it is likewise that the effects of heat are most advanced, when it worketh upon a body without loss or dissipation of the matter; for that ever betrayeth the account. And therefore it is true that the power of heat is best perceived in distillations which are performed in close vessels and receptacles. But yet there is a higher degree; for howsoever distillations do keep the body in cells and cloisters, without going abroad, yet they give space unto bodies to turn into vapour, to return into liquor, and to separate one part from another. So as nature doth expatiate, although it hath not full liberty; whereby the true and ultime operations of heat are not attained. But if bodies may be altered by heat, and yet no such reciprocation of rarefaction and of condensation and of separation admitted, then it is like that this Proteus of matter, being held by the sleeves, will turn and change into many metamorphoses.[1] Take therefore a square vessel of iron, in form of a cube, and let it have good thick and strong sides. Put it into a cube of wood, that may fill it as close as may be,

[1] I do not know what Bacon would have thought of the story told of the Emperor Frederick II. An old commentator on Dante affirms that, in order to prove the non-existence of the soul, the emperor enclosed a criminal in a chest, and kept him there until death took place. The chest being opened, he asked those whom he wished to refute what had become of the soul; but received quite as good an answer as the question deserved, namely, that it had escaped by the same route as the cries which, for some time after being shut in, the unhappy man had been heard to utter.

and let it have a cover of iron, as strong (at least) as the sides; and let it be well luted, after the manner of the chemists. Then place the vessel within burning coals, kept quick kindled, for some few hours' space. Then take the vessel from the fire, and take off the cover, and see what is become of the wood. I conceive that since all inflammation and evaporation are utterly prohibited, and the body still turned upon itself, that one of these two effects will follow: either that the body of the wood will be turned into a kind of *amalagma*, (as the chemists call it,) or that the finer part will be turned into air, and the grosser stick as it were baked and incrustate upon the sides of the vessel; being become of a denser matter than the wood itself, crude. And for another trial, take also water, and put it in the like vessel, stopped as before; but use a gentler heat, and remove the vessel sometimes from the fire; and again, after some small time, when it is cold, renew the heating of it; and repeat this alteration some few times; and if you can once bring to pass, that the water, which is one of the simplest bodies, be changed in colour, odour, or taste, after the manner of compound bodies, you may be sure that there is a great work wrought in nature, and a notable entrance made into strange changes of bodies and productions; and also a way made to do that by fire in small time, which the sun and age do in long time. But of the admirable effects of this distillation in close (for so we will call it), which is like the wombs and matrices of living creatures, where nothing expireth nor separateth, we will speak fully in the due place; not that we aim at the making of Paracelsus' pygmies[1], or any such prodigious follies; but that we know the effects of heat will be such as will scarce fall under the conceit of man, if the force of it be altogether kept in.

Experiment solitary touching the impossibility of annihilation.

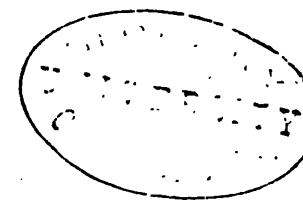
100. There is nothing more certain in nature than that it is impossible for any body to be utterly annihilated; but that as it was the work of the omnipotency of God to make somewhat of nothing, so it requireth the like omnipotency to turn somewhat into nothing. And therefore it is well said by an obscure writer of the sect of the chemists, that there is no such way to

[1] See Paracelsus, De Nymph. Sylph. Pygmæ. et Salam.

effect the strange transmutations of bodies, as to endeavour and urge by all means the reducing of them to nothing. And herein is contained also a great secret of preservation of bodies from change; for if you can prohibit, that they neither turn into air, because no air cometh to them; nor go into the bodies adjacent, because they are utterly heterogeneal; nor make a round and circulation within themselves; they will never change, though they be in their nature never so perishable or mutable. We see how flies, and spiders, and the like, get a sepulchre in amber, more durable than the monument and embalming of the body of any king. And I conceive the like will be of bodies put into quicksilver. But then they must be but thin, as a leaf, or a piece of paper or parchment; for if they have a greater crassitude, they will alter in their own body, though they spend not. But of this we shall speak more when we handle the title of conservation of bodies.

NATURAL HISTORY.

CENTURY II.



Experiments in consort touching Music.

MUSIC, in the practice, hath been well pursued, and in good variety; but in the theory, and especially in the yielding of the causes of the practique, very weakly; being reduced into certain mystical subtilties, of no use and not much truth. We shall, therefore, after our manner, join the contemplative and active part together.

101. All sounds are either musical sounds, which we call tones; whereunto there may be an harmony; which sounds are ever equal; as singing, the sounds of stringed and wind-instruments, the ringing of bells, &c.; or immusical sounds; which are ever unequal; such as are the voice in speaking, all whisperings, all voices of beasts and birds, (except they be singing-birds,) all percussions of stones, wood, parchment, skins (as in drums), and infinite others.

102. The sounds that produce tones, are ever from such bodies as are in their parts and pores equal; as well as the sounds themselves are equal; and such are the percussions of metal, as in bells; of glass, as in the filliping of a drinking glass; of air, as in men's voices whilst they sing, in pipes, whistles, organs, stringed instruments, &c.; and of water, as in the nightingale-pipes of regals[1] or organs, and other hydraulics; which the ancients had, and Nero did so much esteem, but are now lost.[2] And if any man think that the string of the bow

[1] See the note at § 172.

[2] Suetonius in Nero, c. 41. Hydraulic music is mentioned as one of the lost arts by Pancirollo. See his *Raccolta Breve*, &c., i. 7. See also Vitruvius, [lib. v. c. 5.].

and the string of the viol are neither of them equal bodies, and yet produce tones, he is in an error. For the sound is not created between the bow or *plectrum* and the string; but between the string and the air; no more than it is between the finger or quill and the string, in other instruments. So there are (in effect) but three percussions that create tones; percussions of metals (comprehending glass and the like), percussions of air, and percussions of water.

103. The diapason or eighth in music is the sweetest concord; insomuch as it is in effect an unison; as we see in lutes that are strung in the base strings with two strings, one an eighth above another; which make but as one sound. And every eighth note in ascent (as from eight to fifteen, from fifteen to twenty-two, and so *in infinitum*,) are but scales of diapason. The cause is dark, and hath not been rendered by any; and therefore would be better contemplated. It seemeth that air (which is the subject of sounds) in sounds that are not tones (which are all unequal, as hath been said,) admitteth much variety; as we see in the voices of living creatures, and likewise in the voices of several men, (for we are capable to discern several men by their voices,) and in the conjugation of letters, whence articulate sounds proceed; which of all others are most various. But in the sounds which we call tones, (that are ever equal,) the air is not able to cast itself into any such variety; but is forced to recur into one and the same posture or figure, only differing in greatness and smallness. So we see figures may be made of lines, crooked and straight, in infinite variety, where there is inequality; but circles, or squares, or triangles equilateral (which are all figures of equal lines) can differ but in greater or lesser.

104. It is to be noted, (the rather lest any man should think that there is anything in this number of eight, to create the diapason,) that this computation of eight is a thing rather received than any true computation. For a true computation ought ever to be by distribution into equal portions. Now there be intervenient in the rise of eight (in tones) two beemols, or half-notes[1]: so as if you divide the tones equally, the eighth is but seven whole and equal notes; and if you subdivide that into half-notes, (as it is in the stops of a lute,) it maketh the number of thirteen.

[1] Namely, between the third and fourth and between the seventh and eighth.

105. Yet this is true, that in the ordinary rises and falls of the voice of man (not measuring the tone by whole notes and half-notes, which is the equal measure) there fall out to be two beemolls (as hath been said) between the unison and the diapason: and this varying is natural. For if a man would endeavour to raise or fall his voice still by half-notes, like the stops of a lute, or by whole notes alone without halves, as far as an eighth; he will not be able to frame his voice unto it. Which sheweth, that after every three whole notes, nature requireth, for all harmonical use, one half-note to be interposed.

106. It is to be considered, that whatsoever virtue is in numbers for conducing to concent of notes, is rather to be ascribed to the ante-number than to the entire number; as namely, that the sound returneth after six or after twelve; so that the seventh or the thirteenth is not the matter, but the sixth or the twelfth; and the seventh and the thirteenth are but the limits and boundaries of the return.

107. The concords in music which are perfect or semiperfect between the unison and the diapason, are the fifth, which is the most perfect; the third next; and the sixth, which is more harsh: and, as the ancients esteemed, and so do myself and some other yet, the fourth, which they call diatessaron.[1] As for the tenth, twelfth, thirteenth, and so *in infinitum*, they be but recurrences of the former, viz. of the third, the fifth, and the sixth, being an eighth respectively from them.

108. For discords, the second and the seventh are of all others the most odious in harmony to the sense; whereof the one is next above the unison, the other next under the diapason, which may shew that harmony requireth a competent distance of notes.

109. In harmony, if there be not a discord to the base, it doth not disturb the harmony though there be a discord to the higher parts; so the discord be not of the two that are odious; and therefore the ordinary consent of four parts consisteth of

[1] Hawkins remarks, "Hardly any question has been more agitated by the modern musicians than this, whether the diatessaron be a concord or a discord?" He goes on to quote a passage in favour of its being a concord from "a very learned and ingenious book," entitled *Principles of Music, &c.*, by Charles Butler, of Magdalen College, Oxford, 1636. Butler, after arguing the question, proceeds thus: "And therefore that honourable sage [Lord Verulam], whose general knowledge and judgment in all kind of litterature is generally applauded by the learned, rejecting their novel fancy that reject this ancient concord, professes himself to be of another mind,"—and then quotes the passage in the text. See Hawkins, *Hist. of Music*, iii. 134.

an eighth, a fifth, and a third to the base; but that fifth is a fourth to the treble, and the third is a sixth. And the cause is, for that the base striking more air, doth overcome and drown the treble, (unless the discord be very odious); and so hideth a small imperfection. For we see, that in one of the lower strings of a lute, there soundeth not the sound of the treble, nor any mixed sound, but only the sound of the base.

110. We have no music of quarter-notes[1]; and it may be they are not capable of harmony; for we see the half-notes themselves do but interpose sometimes. Nevertheless we have some slides or relishes of the voice or strings, as it were continued without notes from one tone to another, rising or falling, which are delightful.

111. The causes of that which is pleasing or ingrate to the hearing, may receive light by that which is pleasing or ingrate to the sight. There be two things pleasing to the sight, (leaving pictures and shapes aside, which are but secondary objects, and please or displease but in memory); these two are *colours* and *order*. The pleasing of colour symboliseth with the pleasing of any single tone to the ear; but the pleasing of order doth symbolise with harmony. And therefore we see in garden-knots, and the frets of houses, and all equal and well answering figures, (as globes, pyramids, cones, cylinders, &c.,) how they please; whereas unequal figures are but deformities. And both these pleasures, that of the eye, and that of the ear, are but the effects of equality, ~~good proportion~~, or correspondence: so that (out of question) equality and correspondence are the causes of harmony. But to find the proportion of that correspondence, is more abstruse; whereof notwithstanding we shall speak somewhat (when we handle tones) in the general inquiry of sounds.

112. Tones are not so apt altogether to procure sleep as some other sounds; as the wind, the purling of water, humming of bees, a sweet voice of one that readeth, &c. The cause whereof is, for that tones, because they are equal and slide not, do more strike and erect the sense than the other. And overmuch attention hindereth sleep.

113. There be in music certain figures or tropes; almost agreeing with the figures of rhetoric, and with the affections

[1] The diesis or quarter-note does not enter into our scales, but it did into the enharmonic scale of the Greeks.

of the mind, and other senses. First, the division and quavering, which please so much in music, have an agreement with the glittering of light; as the moon-beams playing upon a wave. Again, the falling from a discord to a concord, which maketh great sweetness in music, hath an agreement with the affections, which are reintegrated to the better after some dislikes; it agreeth also with the taste, which is soon glutted with that which is sweet alone. The sliding from the close or cadence, hath an agreement with the figure in rhetoric which they call *præter expectatum*; for there is a pleasure even[1] in being deceived. The reports and fuges have an agreement with the figures in rhetoric of repetition and traduction. The tripla's, and changing of times, have an agreement with the changes of motions; as when galliard time and measure time are in the medley of one dance.[2]

114. It hath been anciently held and observed, that the sense of hearing and the kinds of music have most operation upon manners; as to encourage men and make them warlike; to make them soft and effeminate; to make them grave; to make them light; to make them gentle and inclined to pity, &c. The cause is, for that the sense of hearing striketh the spirits more immediately than the other senses, and more incorporeally than the smelling. For the sight, taste, and feeling, have their organs not of so present and immediate access to the spirits, as the hearing hath. And as for the smelling, (which indeed worketh also immediately upon the spirits, and is forcible while the object remaineth,) it is with a communication of the breath or vapour of the object odorate; but harmony, entering easily, and mingling not at all, and coming with a manifest motion, doth by custom of often affecting the spirits and putting them into one kind of posture, alter not a little the nature of the spirits, even when the object is removed. And therefore we see that tunes and airs, even in their own nature, have in themselves some affinity with the affections: as there be merry tunes, doleful tunes, solemn tunes; tunes inclining men's minds to pity; warlike tunes, &c. So as it is no marvel if they alter the spirits, considering that tunes have a predisposition to the motion of the spirits in themselves. But yet it hath been

[1] So in the original; a mistake probably for *ever*.—*J. S.*

[2] Compare this passage with the [*De Augmentis*, iii. 1. and the corresponding passage in the] *Advancement of Learning*.

noted, that though this variety of tunes doth dispose the spirits to variety of passions conform unto them, yet generally music feedeth that disposition of the spirits which it findeth. We see also that several airs and tunes do please several nations and persons, according to the sympathy they have with their spirits.

Experiments in consort touching sounds; and first touching the nullity and entity of sounds.

Perspective hath been with some diligence inquired; and so hath the nature of sounds, in some sort, as far as concerneth music. But the nature of sounds in general hath been superficially observed. It is one of the subtilest pieces of nature. And besides, I practise as I do advise; which is, after long inquiry of things immerse in matter, to interpose some subject which is immateriate, or less materiate; such as this of sounds; to the end that the intellect may be rectified, and become not partial.

115. It is first to be considered, what great motions there are in nature which pass without sound or noise. The heavens turn about in a most rapid motion, without noise to us perceived; though in some dreams they have been said to make an excellent music. So the motions of the comets, and fiery meteors (as "stella cadens," &c.) yield no noise. And if it be thought that it is the greatness of distance from us, whereby the sound cannot be heard; we see that lightnings and coruscations, which are near at hand, yield no sound neither. And yet in all these there is a percussion and division of the air. The winds in the upper region (which move the clouds above, which we call the *rack*, and are not perceived below,) pass without noise. The lower winds in a plain, except they be strong, make no noise; but amongst trees, the noise of such winds will be perceived. And the winds (generally) when they make a noise, do ever make it unequally, rising and falling, and sometimes (when they are vehement) trembling at the height of their blast. Rain or hail falling (though vehemently) yieldeth no noise in passing through the air, till it fall upon the ground, water, houses, or the like. Water in a river (though a swift stream) is not heard in the channel, but runneth in silence, if it be of any depth; but the very stream upon shallows, of gravel or pebble, will be heard.

And waters, when they beat upon the shore, or are straitened (as in the falls of bridges), or are dashed against themselves by winds, give a roaring noise. Any piece of timber or hard body, being thrust forwards by another body contiguous without knocking, giveth no noise. And so bodies in weighing one upon another, though the upper body press the lower body down, make no noise. So the motion in the minute parts of any solid body (which is the principal cause of violent motion, though unobserved,) passeth without sound; for that sound that is heard sometimes, is produced only by the breaking of the air, and not by the impulsion of the parts. So it is manifest that where the anterior body giveth way as fast as the posterior cometh on, it maketh no noise, be the motion never so great or swift.

116. Air open, and at large, maketh no noise, except it be sharply percussed; as in the sound of a string, where air is percussed by a hard and stiff body, and with a sharp loose; for if the string be not strained, it maketh no noise. But where the air is pent and straitened, there breath or other blowing, (which carry but a gentle percussion) suffice to create sound; as in pipes and wind-instruments. But then you must note, that in recorders, which go with a gentle breath, the concave of the pipe, were it not for the fipple that straiteneth the air (much more than the simple concave), would yield no sound. For as for other wind-instruments, they require a forcible breath; as trumpets, cornets, hunters' horns, &c., which appeareth by the blown cheeks of him that windeth them. Organs also are blown with a strong wind by the bellows. And note again, that some kind of wind-instruments are blown at a small hole in the side, which straiteneth the breath at the first entrance; the rather, in respect of their traverse and stop above the hole, which performeth the fipple's part; as it is seen in flutes and fifes, which will not give sound by a blast at the end, as recorders &c. do. Likewise in all whistling, you contract the mouth; and to make it more sharp, men sometimes use their finger. But in open air, if you throw a stone or a dart, they give no sound; no more do bullets, except they happen to be a little hollowed in the casting; which hollowness penneth the air: nor yet arrows, except they be ruffled in their feathers, which likewise penneth the air. As for small whistles, or shepherds' oaten pipes, they give a sound because of their

extreme slenderness, whereby the air is more pent than in a wider pipe. Again, the voices of men and living creatures pass through the throat, which penneth the breath. As for the Jews-harp, it is a sharp percussion; and besides hath the advantage of penning the air in the mouth.

117. Solid bodies, if they be very softly percussed, give no sound; as when a man treadeth very softly upon boards. So chests or doors in fair weather, when they open easily, give no sound. And cart-wheels squeak not when they are liquored.

118. The flame of tapers or candles, though it be a swift motion and breaketh the air, yet passeth without sound. Air in ovens, though (no doubt) it doth (as it were) boil and dilate itself, and is repercussed, yet it is without noise.

119. Flame percussed by air giveth a noise; as in blowing of the fire by bellows; greater than if the bellows should blow upon the air itself. And so likewise flame percussing the air strongly (as when flame suddenly taketh and openeth) giveth a noise; so great flames, while the one impelleth the other, give a bellowing sound.

120. There is a conceit runneth abroad, that there should be a white powder, which will discharge a piece without noise; which is a dangerous experiment, if it should be true: for it may cause secret murders. But it seemeth to me unpossible; for if the air pent be driven forth and strike the air open, it will certainly make a noise. As for the white powder, (if any such thing be, that may extinguish or dead the noise,) it is like to be a mixture of petre and sulphur, without coal. For petre alone will not take fire. And if any man think that the sound may be extinguished or deaded by discharging the pent air before it cometh to the mouth of the piece and to the open air, that is not probable; for it will make more divided sounds: as if you should make a cross barrel hollow through the barrel of a piece, it may be it would give several sounds, both at the nose and the sides. But I conceive that if it were possible to bring to pass that there should be no air pent at the mouth of the piece, the bullet might fly with small or no noise. For first, it is certain there is no noise in the percussion of the flame upon the bullet. Next, the bullet in piercing through the air maketh no noise; as hath been said. And then, if there be no pent air that striketh upon open air, there is no cause of noise; and yet the flying of the bullet will not be stayed. For that

motion (as hath been oft said) is in the parts of the bullet, and not in the air. So as trial must be made by taking some small concave of metal, no more than you mean to fill with powder, and laying the bullet in the mouth of it, half out in the open air.

121. I heard it affirmed by a man that was a great dealer in secrets, but he was but vain, that there was a conspiracy (which himself hindered) to have killed Queen Mary, sister to Queen Elizabeth, by a burning-glass, when she walked in St. James's Park, from the leads of the house. But thus much (no doubt) is true; that if burning-glasses could be brought to a great strength (as they talk generally of burning-glasses that are able to burn a navy[1]) the percussion of the air alone by such a burning-glass would make no noise; no more than is found in coruscations and lightnings without thunders.

122. I suppose that impression of the air with sounds asketh a time to be conveyed to the sense, as well as the impression of species visible; or else they will not be heard. And therefore, as the bullet moveth so swift that it is invisible, so the same swiftness of motion maketh it inaudible: for we see that the apprehension of the eye is quicker than that of the ear.

123. All eruptions of air, though small and slight, give an entity of sound; which we call crackling, puffing, spitting, &c., as in bay-salt, and bay-leaves, cast into the fire: so in chest-nuts, when they leap forth of the ashes; so in green wood laid upon the fire, especially roots; so in candles, that spit flame if they be wet; so in rasping, sneezing, &c.; so in a rose-leaf gathered together into the fashion of a purse, and broken upon the forehead or back of the hand, as children use.

Experiments in consort touching production, conservation, and delation of sounds; and the office of the air therein.

124. The cause given of sound, that it should be an elision of the air (whereby, if they mean anything, they mean a cutting or dividing, or else an attenuating of the air) is but a term of ignorance; and the notion[2] is but a catch of the wit upon a few instances; as the manner is in the philosophy received. And it is common with men, that if they have gotten a pretty expression by a word of art, that expression goeth current,

[1] The story of Archimedes's burning the Roman fleet, rests on no good foundation. The authorities are collected by Peyrard in an appendix to his edition of Archimedes.

[2] *Motion* in the original. — *J. S.*

though it be empty of matter. This conceit of elision appeareth most manifestly to be false, in that the sound of a bell, string, or the like, continueth melting some time after the percussion; but ceaseth straightways, if the bell or string be touched and stayed; whereas, if it were the elision of the air that made the sound, it could not be that the touch of the bell or string should extinguish so suddenly that motion caused by the elision of the air. This appeareth yet more manifestly by chiming with a hammer upon the outside of a bell: for the sound will be according to the inward concave of the bell: whereas the elision or attenuation of the air cannot be but only between the hammer and the outside of the bell. So again, if it were an elision, a broad hammer, and a bodkin, struck upon metal, would give a diverse tone, as well as a diverse loudness: but they do not so: for though the sound of the one be louder, and of the other softer, yet the tone is the same. Besides, in echoes, (whereof some are as loud as the original voice,) there is no new elision, but a repercussion only. But that which convinceth it most of all is, that sounds are generated where there is no air at all. But these and the like conceits, when men have cleared their understanding by the light of experience, will scatter and break up like a mist.

125. It is certain that sound is not produced at the first, but with some local motion of the air, or flame, or some other medium; nor yet without some resistance, either in the air or the body percussed. For if there be a mere yielding or cession, it produceth no sound; as hath been said. And therein sounds differ from light or colours; which pass through the air, or other bodies, without any local motion of the air; either at the first or after. But you must attentively distinguish between the local motion of the air (which is but *vehiculum causæ*, a carrier of the sounds) and the sounds themselves conveyed in the air. For as to the former, we see manifestly that no sound is produced (no not by air itself against other air, as in organs, &c.) but with a perceptible blast of the air; and with some resistance of the air strucken. For even all speech (which is one of the gentlest motions of air) is with expulsion of a little breath. And all pipes have a blast, as well as a sound. We see also manifestly that sounds are carried with wind; and therefore sounds will be heard further with the wind than against the wind; and likewise do rise and fall with the intension or re-

mission of the wind. But for the impression of the sound, it is quite another thing, and is utterly without any local motion of the air, perceptible; and in that resembleth the species visible: for after a man hath lured, or a bell is rung, we cannot discern any perceptible motion at all in the air along as the sound goeth; but only at the first. Neither doth the wind (as far as it carrieth a voice) with the motion thereof confound any of the delicate and articulate figurations of the air, in variety of words. And if a man speak a good loudness against the flame of a candle, it will not make it tremble much; though most when those letters are pronounced which contract the mouth; as F, S, V, and some others. But gentle breathing, or blowing without speaking, will move the candle far more. And it is the more probable that sound is without any local motion of the air, because as it differeth from the sight in that it needeth a local motion of the air at first, so it paralleleth in so many other things with the sight and radiation of things invisible; which (without all question) induce no local motion in the air, as hath been said.

126. Nevertheless it is true, that upon the noise of thunder, and great ordnance, glass windows will shake; and fishes are thought to be frayed with the motion caused by noise upon the water.[1] But these effects are from the local motion of the air which is a concomitant of the sound (as hath been said), and not from the sound.

127. It hath been anciently reported[2], and is still received, that extreme applauses and shouting of people assembled in great multitudes, have so rarified and broken the air, that birds flying over have fallen down, the air being not able to support them. And it is believed by some, that great ringing of bells in populous cities hath chased away thunder, and also dissipated pestilent air: all which may be also from the concussion of the air, and not from the sound.

128. A very great sound, near hand, hath strucken many deaf; and at the instant they have found, as it were, the breaking of a skin of parchment in their ear: and myself standing near one that lured[3] loud and shrill, had suddenly an offence,

[1] Similarly it has been observed that discharge of artillery is injurious to lobsters.

[2] Plutarch in Flaminius, p. 375.

[3] To lure is properly to bring the falcon back by showing him the lure, an imitation of a bird, sometimes baited with a piece of flesh; secondarily, as in the text, to bring

as if somewhat had broken or been dislocated in my ear; and immediately after a loud ringing (not an ordinary singing or hissing, but far louder and differing) so as I feared some deafness. But after some half quarter of an hour it vanished. This effect may be truly referred unto the sound: for (as is commonly received) an over-potent object doth destroy the sense; and spiritual species (both visible and audible) will work upon the sensories, though they move not any other body.

129. In delation of sounds, the inclosure of them preserveth them, and causeth them to be heard further. And we find in rolls of parchment or trunks[1], the mouth being laid to the one end of the roll of parchment or trunk, and the ear to the other, the sound is heard much further than in the open air. The cause is, for that the sound spendeth and is dissipated in the open air; but in such concaves it is conserved and contracted. So also in a piece of ordnance, if you speak in the touch-hole, and another lay his ear to the mouth of the piece, the sound passeth, and is far better heard, than in the open air.

130. It is further to be considered, how it proveth and worketh when the sound is not inclosed all the length of his way, but passeth partly through open air; as where you speak some distance from a trunk; or where the ear is some distance from the trunk at the other end; or where both mouth and ear are distant from the trunk. And it is tried, that in a long trunk of some eight or ten foot, the sound is holpen, though both the mouth and the ear be a handful or more from the ends of the trunk; and somewhat more holpen, when the ear of the hearer is near, than when the mouth of the speaker. And it is certain that the voice is better heard in a chamber from abroad, than abroad from within the chamber.

131. As the inclosure that is round about and entire, preserveth the sound; so doth a semi-concave, though in a less degree. And therefore, if you divide a trunk or a cane into two, and one speak at the one end, and you lay your ear at the other, it will carry the voice further than in the air at large. Nay further, if it be not a full semi-concave, but if you do the like upon the mast of a ship, or a long pole, or a piece of ordnance, (though one speak upon the surface of the ordnance, and

him back by whistling. *Lure*, in French *leurre* and *loirre*, is primarily *lorum*, the thong to which the falcon is attached. See Menage in voc.

[1] It is worth notice that telescopes were at first called "trunks;" as for instance by Harriott.

not at any of the bores,) the voice will be heard further than in the air at large.

132. It would be tried, how, and with what proportion of disadvantage, the voice will be carried in an horn, which is a line arched; or in a trumpet, which is a line retorted; or in some pipe that were sinuous.

133. It is certain (howsoever it cross the received opinion) that sounds may be created without air, though air be the most favourable deferent of sounds. Take a vessel of water, and knap a pair of tongs some depth within the water, and you shall hear the sound of the tongs well, and not much diminished; and yet there is no air at all present.

134. Take one vessel of silver, and another of wood; and fill each of them full of water; and then knap the tongs together, as before, about an handful from the bottom; and you shall find the sound much more resounding from the vessel of silver, than from that of wood; and yet if there be no water in the vessel, so that you knap the tongs in the air, you shall find no difference between the silver and the wooden vessel. Whereby, beside the main point of creating sound without air, you may collect two things: the one, that the sound communicateth with the bottom of the vessel; the other, that such a communication passeth far better through water than air.

135. Strike any hard bodies together in the midst of a flame; and you shall hear the sound with little difference from the sound in the air.

136. The pneumatical part, which is in all tangible bodies, and hath some affinity with the air, performeth in some degree the parts of the air; as when you knock upon an empty barrel, the sound is in part created by the air on the outside, and in part by the air in the inside; for the sound will be greater or lesser, as the barrel is more empty or more full; but yet the sound participateth also with the spirit in the wood, through which it passeth, from the outside to the inside. And so it cometh to pass in the chiming of bells on the outside; where also the sound passeth to the inside. And a number of other like instances, whereof we shall speak more when we handle the communication of sounds.

137. It were extreme grossness to think (as we have partly touched before) that the sound in strings is made or produced between the hand and the string, or the quill and the string, or

the bow and the string, for those are but *vehicula motus*, passages to the creation of the sound; the sound being produced between the string and the air; and that not by any impulsion of the air from the first motion of the string, but by the return or result of the string, which was strained by the touch, to his former place; which motion of result is quick and sharp; whereas the first motion is soft and dull. So the bow tortureth the string continually, and thereby holdeth it in a continual trepidation.

Experiments in consort touching the magnitude and exility and damps of sound.

138. Take a trunk, and let one whistle at the one end, and hold your ear to the other, and you shall find the sound strike so sharp as you can scarce endure it. The cause is, for that sound diffuseth itself in round, and so spendeth itself; but if the sound, which would scatter in open air, be made to go all into a canal, it must needs give greater force to the sound. And so you may note that inclosures do not only preserve sound, but also increase and sharpen it.

139. A hunter's horn being greater at one end than at the other, doth increase the sound more than if the horn were all of an equal bore. The cause is, for that the air and sound being first contracted at the lesser end, and afterwards having more room to spread at the greater end, do dilate themselves; and in coming out strike more air; whereby the sound is the greater and baser. And even hunters' horns, which are sometimes made straight and not oblique, are ever greater at the lower end. It would be tried also in pipes, being made far larger at the lower end; or being made with a belly towards the lower end, and then issuing into a straight concave again.

140. There is in St. James's Fields a conduit of brick, unto which joineth a low vault; and at the end of that a round house of stone; and in the brick conduit there is a window; and in the round house a slit or rift of some little breadth; if you cry out in the rift, it will make a fearful roaring at the window.[1] The cause is the same with the former; for that all concaves that proceed from more narrow to more broad, do amplify the sound at the coming out.

[1] Mr. Timbs, in his *Curiosities of London*, refers to this passage, and states that the conduit in question stood near the spot now occupied by the statue of William III. in the garden of St. James's Square.

141. Hawks' bells, that have holes in the sides, give a greater ring, than if the pellet did strike upon brass in the open air. The cause is the same with the first instance of the trunk; namely, for that the sound inclosed with the sides of the bell cometh forth at the holes unspent and more strong.

142. In drums, the closeness round about, that preserveth the sound from dispersing, maketh the noise come forth at the drum-hole far more loud and strong than if you should strike upon the like skin extended in the open air. The cause is the the same with the two precedent.

143. Sounds are better heard, and further off, in an evening or in the night, than at the noon or in the day. The cause is, for that in the day, when the air is more thin, no doubt, the sound pierceth better; but when the air is more thick, as in the night, the sound spendeth and spreadeth abroad less: and so it is a degree of inclosure. As for the night, it is true also that the general silence helpeth.

144. There be two kinds of reflexions of sounds; the one at distance, which is the echo; wherein the original is heard distinctly, and the reflexion also distinctly; of which we shall speak hereafter: the other in concurrence; when the sound reflecting (the reflexion being near at hand) returneth immediately upon the original, and so iterateth it not, but amplifieth it. Therefore we see that music upon the water soundeth more; and so likewise music is better in chambers wainscotted than hanged.

145. The strings of a lute, or viol, or virginals, do give a far greater sound, by reason of the knot, and board, and concave underneath, than if there were nothing but only the flat of a board, without that hollow and knot, to let in the upper air into the lower. The cause is, the communication of the upper air with the lower, and penning of both from expence or dispersing.

146. An Irish harp hath open air on both sides of the strings: and it hath the concave or belly not along the strings, but at the end of the strings. It maketh a more resounding sound than a bandora, orpharion, or cittern[1], which have likewise wire-strings. I judge the cause to be, for that open air on both sides helpeth,

[1] The cittern and the lute are probably the same instrument. See Hawkins's *Hist. of Music*, iii. 162.; and for the bandora and orpharion, iii. 344.

so that there be a concave; which is therefore best placed at the end.

147. In a virginal, when the lid is down, it maketh a more exile sound than when the lid is open. The cause is, for that all shutting in of air, where there is no competent vent, dampeth the sound: which maintaineth likewise the former instance; for the belly of the lute or viol doth pen the air somewhat.

148. There is a church at Gloucester, (and, as I have heard, the like is in some other places), where if you speak against a wall softly, another shall hear your voice better a good way off, than near at hand. Inquire more particularly of the frame of that place. I suppose there is some vault, or hollow, or isle[1], behind the wall, and some passage to it towards the further end of that wall against which you speak; so as the voice of him that speaketh slideth along the wall, and then entereth at some passage, and communicateth with the air of the hollow; for it is preserved somewhat by the plain wall; but that is too weak to give a sound audible, till it hath communicated with the back air.[2]

149. Strike upon a bow-string, and lay the horn of the bow near your ear, and it will increase the sound, and make a degree of a tone. The cause is, for that the sensory, by reason of the close holding, is percussed before the air disperseth. The like is, if you hold the horn betwixt your teeth: but that is a plain delation of the sound; from the teeth to the instrument of hearing; for there is a great intercourse between those two parts; as appeareth by this, that a harsh grating tune setteth the teeth on edge. The like falleth out, if the horn of the bow be put upon the temples; but that is but the slide of the sound from thence to the ear.

150. If you take a rod of iron or brass, and hold the one end to your ear, and strike upon the other, it maketh a far greater sound than the like stroke upon the rod not so made contiguous to the ear. By which, and by some other instances that have been partly touched, it should appear, that sounds do not only slide upon the surface of a smooth body, but do also communicate with the spirits that are in the pores of the body.

151. I remember in Trinity College in Cambridge, there

[1] So in the original. I suppose *aisle* is meant. — *J. S.*

[2] The church referred to is the cathedral, and the length of the gallery is said to be twenty-five yards. See Rudder, *History of Gloucestershire*, p. 178.

was an upper chamber, which being thought weak in the roof of it, was supported by a pillar of iron of the bigness of one's arm, in the midst of the chamber; which if you had struck, it would make a little flat noise in the room where it was struck, but it would make a great bomb in the chamber beneath.[1]

152. The sound which is made by buckets in a well, when they touch upon the water, or when they strike upon the side of the well, or when two buckets dash the one against the other; these sounds are deeper and fuller than if the like percussion were made in the open air. The cause is, the penning and inclosure of the air in the concave of the well.

153. Barrels placed in a room under the floor of a chamber, make all noises in the same chamber more full and resounding.

So that there be five ways (in general) of majoration in sounds: inclosure simple; inclosure with dilatation; communication; reflexion concurrent; and approach to the sensory.

154. For exility of the voice or other sounds; it is certain that the voice doth pass through solid and hard bodies, if they be not too thick; and through water, which is likewise a very close body, and such an one as letteth not in air. But then the voice, or other sound, is reduced by such passage to a great weakness or exility. If therefore you stop the holes of a hawk's bell, it will make no ring, but a flat noise or rattle. And so doth the *aëtites* or eagle's-stone, which hath a little stone within it.[2]

155. And as for water, it is a certain trial: let a man go into a bath, and take a pail, and turn the bottom upward, and carry the mouth of it (even) down to the level of the water, and so press it down under the water some handful and an half, still keeping it even, that it may not tilt on either side, and so the air get out: then let him that is in the bath dive with his head so far under water, as he may put his head into the pail; and there will come as much air bubbling forth, as will make room for his head. Then let him speak; and any that shall stand without shall hear his voice plainly; but yet made extreme sharp and exile, like the voice of puppets: but

[1] Mr. Edleston, fellow and steward of the college, who is probably as conversant with its history as any member of the present society, informs me that nothing is known of this chamber, and that he is therefore disposed to believe that it formed part of the buildings removed in the first years of the 17th century, in order to make room for what is now the Old Court.

[2] Pliny, x. 4.

yet the articulate sounds of the words will not be confounded. Note that it may be much more handsomely done, if the pail be put over the man's head above water, and then he cower down, and the pail be pressed down with him. Note that a man must kneel or sit, that he may be lower than the water. A man would think that the Sicilian poet had knowledge of this experiment; for he saith that Hercules' page, Hylas, went with a water-pot to fill it at a pleasant fountain that was near the shore, and that the nymphs of the fountain fell in love with the boy, and pulled him under the water, keeping him alive; and that Hercules missing his page, called him by his name aloud, that all the shore rang of it; and that Hylas from within the water answered his master, but (that which is to the present purpose) with so small and exile a voice, as Hercules thought he had been three miles off, when the fountain indeed was fast by.[1]

156. In lutes and instruments of strings, if you stop a string high (whereby it hath less scope to tremble) the sound is more treble, but yet more dead.

157. Take two saucers, and strike the edge of the one against the bottom of the other, within a pail of water; and you shall find, that as you put the saucers lower and lower, the sound groweth more flat; even while part of the saucer is above the water; but that flatness of sound is joined with a harshness of sound; which no doubt is caused by the inequality of the sound which cometh from the part of the saucer under the water, and from the part above. But when the saucer is wholly under the water, the sound becometh more clear, but far more low; and as if the sound came from afar off.

158. A soft body dampeth the sound much more than a hard; as if a bell hath cloth or silk wrapped about it, it deadeth the sound more than if it were wood. And therefore in clericals[2] the keys are lined; and in colleges they use to line the tablemen.[3]

[1] Theocrit. Id. xiii. Poisson has shown *à priori* that in passing from water into air the intensity of sound is diminished in the ratio of 1:200, and vice versâ in passing from air into water as 1:3600. The exility of tone mentioned in the text is connected with the velocity of propagation, which is four times as great in water as in air.

[2] Johnson suggests Claricords. But Clerical seems to be analogous to Regal and Virginal, which are known musical instruments. Luscinius, quoted by Hawkins, *Hist. of Music*, ii. 442., says that the clavichord or clarichord is used by the nuns in convents, and that in order not to disturb the sisters in the dormitory, the strings are muffled with small bits of fine woollen cloth.

[3] The tablemen are manifestly a part of some musical instrument. The only sense in which the word is commonly used, namely men for playing draughts, is irrelevant.

159. Trial was made in a recorder[1] after these several manners. The bottom of it was set against the palm of the hand; stopped with wax round about; set against a damask cushion; thrust into sand; into ashes; into water (half an inch under the water); close to the bottom of a silver basin; and still the tone remained. But the bottom of it was set against a woollen carpet; a lining of plush; a lock of wool (though loosely put in); against snow; and the sound of it was quite deaded, and but breath.

160. Iron hot produceth not so full a sound as when it is cold; for while it is hot, it appeareth to be more soft and less resounding. So likewise warm water, when it falleth, maketh not so full a sound as cold[2]; and I conceive it is softer, and nearer the nature of oil; for it is more slippery, as may be seen in that it scowreth better.

161. Let there be a recorder made with two fipples, at each end one: the trunk of it of the length of two recorders, and the holes answerable towards each end; and let two play the same lesson upon it, at an unison; and let it be noted whether the sound be confounded, or amplified, or dulled. So likewise, let a cross be made of two trunks, throughout hollow; and let two speak or sing, the one longways, the other traverse: and let two hear at the opposite ends; and note whether the sound be confounded, amplified, or dulled. Which two instances will also give light to the mixture of sounds; whereof we shall speak hereafter.

162. A bellows blown in at the hole of a drum, and the drum then strucken, maketh the sound a little flatter, but no other apparent alteration. The cause is manifest: partly for that it hindereth the issue of the sound, and partly for that it maketh the air, being blown together, less moveable.

Experiments in consort touching the loudness or softness of sounds, and their carriage at longer or shorter distance.

163. The loudness and softness of sounds is a thing distinct from the magnitude and exility of sounds; for a base string, though softly strucken, giveth the greater sound; but a treble string, if hard strucken, will be heard much further off. And the cause is, for that the base string striketh more air; and the treble less air, but with a sharper percussion.

[1] The recorder was a kind of flute.

[2] Arist. Prob. xi. 10.

164. It is therefore the strength of the percussion, that is a principal cause of the loudness or softness of sounds; as in knocking harder or softer; winding of a horn stronger or weaker; ringing of a hand-bell harder or softer, &c. And the strength of this percussion consisteth as much or more in the hardness of the body percussed, as in the force of the body percussing: for if you strike against a cloth, it will give a less sound; if against wood, a greater; if against metal, yet a greater; and in metals, if you strike against gold (which is the more pliant), it giveth the flatter sound; if against silver or brass, the more ringing sound. As for air, where it is strongly pent, it matcheth a hard body. And therefore we see in discharging of a piece, what a great noise it maketh. We see also, that the charge with bullet, or with paper wet and hard stopped, or with powder alone rammed in hard, maketh no great difference in the loudness of the report.

165. The sharpness or quickness of the percussion is a great cause of the loudness, as well as the strength; as in a whip or wand, if you strike the air with it; the sharper and quicker you strike it, the louder sound it giveth. And in playing upon the lute or virginals, the quick stroke or touch is a great life to the sound. The cause is, for that the quick striking cutteth the air speedily; whereas the soft striking doth rather beat than cut.

Experiments in consort touching the communication of sounds.

The communication of sounds (as in bellies of lutes, empty vessels, &c.) hath been touched *obiter* in the majoration of sounds; but it is fit also to make a title of it apart.

166. The experiment for greatest demonstration of communication of sounds, is the chiming of bells; where if you strike with a hammer upon the upper part, and then upon the midst, and then upon the lower, you shall find the sound to be more treble and more base according unto the concave on the inside, though the percussion be only on the outside.

167. When the sound is created between the blast of the mouth and the air of the pipe, it hath nevertheless some communication with the matter of the sides of the pipe, and the spirits in them contained; for in a pipe or trumpet, of wood and brass,

the sound will be diverse; so if the pipe be covered with cloth or silk, it will give a diverse sound from that it would do of itself; so if the pipe be a little wet on the inside, it will make a differing sound from the same pipe dry.

168. That sound made within water doth communicate better with a hard body through water, than made in air it doth with air, *vide experimentum* 134.

Experiments in consort touching equality and inequality of sounds.

We have spoken before (in the inquisition touching music) of musical sounds whereunto there may be a concord or discord in two parts; which sounds we call tones; and likewise of immusical sounds; and have given the cause, that the tone proceedeth of equality, and the other of inequality. And we have also expressed there, what are the equal bodies that give tones, and what are the unequal that give none. But now we shall speak of such inequality of sounds, as proceedeth not from the nature of the bodies themselves, but is accidental; either from the roughness or obliquity of the passage, or from the doubling of the percutient, or from the trepidation of the motion.

169. A bell, if it have a rift in it, whereby the sound hath not a clear passage, giveth a hoarse and jarring sound: so the voice of man, when by cold taken the weasil groweth rugged, and (as we call it) furred, becometh hoarse. And in these two instances the sounds are ingrate, because they are merely unequal: but if they be unequal in equality, then the sound is grateful, but purling.

170. All instruments that have either returns, as trumpets; or flexions, as cornets; or are drawn up and put from, as sackbuts; have a purling sound: but the recorder or flute, that have none of these inequalities, give a clear sound. Nevertheless, the recorder itself, or pipe, moistened a little in the inside, soundeth more solemnly, and with a little purling or hissing. Again, a wreathed string, such as are in the base strings of bandoras, giveth also a purling sound.[1]

[1] The varying sounds of the kettle suggested a curious fancy to the Finns. According to them the confusion of tongues was caused by a kettle which came down from heaven, and from the varying noises of which each family learnt a different language. V. Grimm on the Origin of Language.

171. But a lute-string, if it be merely unequal in his parts, giveth a harsh and untuneable sound; which strings we call *false*, being bigger in one place than in another; and therefore wire strings are never false. We see also, that when we try a false lute-string, we use to extend it hard between the fingers, and to fillip it; and if it giveth a double species, it is true; but if it giveth a treble, or more, it is false.[1]

172. Waters, in the noise they make as they run, represent to the ear a trembling noise; and in regals[2] (where they have a pipe they call the nightingale-pipe, which containeth water) the sound hath a continual trembling: and children have also little things they call cocks, which have water in them; and when they blow or whistle in them, they yield a trembling noise; which trembling of water hath an affinity with the letter *L*. All which inequalities of trepidation are rather pleasant than otherwise.

173. All base notes, or very treble notes, give an asper sound; for that the base striketh more air, than it can well strike equally; and the treble cutteth the air so sharp, as it returneth too swift to make the sound equal: and therefore a mean or tenor is the sweetest part.

174. We know nothing that can at pleasure make a musical or immusical sound by voluntary motion, but the voice of man and birds. The cause is (no doubt) in the weasil or windpipe (which we call *aspera arteria*[3]), which being well extended, gathereth equality; as a bladder that is wrinkled, if it be extended, becometh smooth. The extension is always more in tones than in speech: therefore the inward voice or whisper can never give a tone. And in singing, there is manifestly a greater working and labour of the throat, than in speaking; as appeareth in the thrusting out or drawing in of the chin, when we sing.

175. The humming of bees is an unequal buzzing, and is conceived by some of the ancients not to come forth at their

[1] Bacon took this from Le Roy's *Instruction de partir toute Musique, &c.*, of which an English translation was published in 1574. See Hawkins's *History of Music*, iii. 166.

[2] See for some account of this instrument, Hawkins's *Hist. of Music*, ii. 448.

[3] This name for the windpipe, and its Greek equivalent τραχεῖα, owe their origin to the theory according to which all the arteries are air-vessels. It is worthy of notice that Aristotle uses the word ἀρτηρία to denote the windpipe exclusively, applying φλέψ to veins and arteries indiscriminately. He was not however unaware that there is a material difference in the structure of the two classes of blood-vessels.

mouth, but to be an inward sound[1]; but (it may be) it is neither; but from the motion of their wings: for it is not heard but when they stir.

176. All metals quenched in water give a sibilation or hissing sound (which hath an affinity with the letter *Z*); notwithstanding the sound be created between the water or vapour and the air. Seething also, if there be but small store of water in a vessel, giveth a hissing sound; but boiling in a full vessel giveth a bubbling sound, drawing somewhat near to the cocks used by children.

177. Trial would be made, whether the inequality or interchange of the medium will not produce an inequality of sound; as if three bells were made one within another, and air betwixt each, and then the outermost bell were chimed with a hammer; how the sound would differ from a simple bell. So likewise, take a plate of brass and a plank of wood, and join them close together, and knock upon one of them, and see if they do not give an unequal sound. So make two or three partitions of wood in a hogshead, with holes or knots in them; and mark the difference of their sound from the sound of an hogshead without such partitions.

Experiments in consort touching the more treble and the more base tones, or musical sounds.

178. It is evident, that the percussion of the greater quantity of air causeth the baser sound, and the less quantity the more treble sound. The percussion of the greater quantity of air is produced by the greatness of the body percussing; by the latitude of the concave by which the sound passeth; and by the longitude of the same concave. Therefore we see that a base string is greater than a treble; a base pipe hath a greater bore than a treble; and in pipes and the like, the lower the note-holes be, and the further off from the mouth of the pipe, the more base sound they yield; and the nearer the mouth, the more treble. Nay more, if you strike an entire

[1] Arist. Hist. An. iv. 9., and Pliny, xi. 112. That the humming sound emitted by many insects is not due to the motion of their wings, appears according to Burmeister's experiments to be certain, as it continues after the wings are cut off, though with a change of note. His theory is that it is caused merely by breathing through the thoracic air-holes as the insect does when on the wing—the breathing going on silently while it is at rest through the abdominal air-holes. V. Taylor, Scientific Memoirs, i. 377.

body, as an andiron of brass, at the top, it maketh a more treble sound; and at the bottom a baser.

179. It is also evident, that the sharper or quicker percussion of air causeth the more treble sound; and the slower or heavier, the more base sound. So we see in strings: the more they are wound up and strained, (and thereby give a more quick start-back,) the more treble is the sound; and the slacker they are, or less wound up, the baser is the sound. And therefore a bigger string more strained, and a lesser string less strained, may fall into the same tone.

180. Children, women, eunuchs, have more small and shrill voices than men.[1] The reason is, not for that men have greater heat, which may make the voice stronger, (for the strength of a voice or sound doth make a difference in the loudness or softness, but not in the tone); but from the dilatation of the organ; which (it is true) is likewise caused by heat. But the cause of changing the voice at the years of puberty, is more obscure. It seemeth to be, for that when much of the moisture of the body, which did before irrigate the parts, is drawn down to the spermatical vessels, it leaveth the body more hot than it was; whence cometh the dilatation of the pipes: for we see plainly all effects of heat do then come on; as pilosity, more roughness of the skin, hardness of the flesh, &c.

181. The industry of the musician hath produced two other means of straining or intension of strings, besides their winding up. The one is the stopping of the string with the finger; as in the necks of lutes, viols, &c. The other is the shortness of the string, as in harps, virginals, &c. Both these have one and the same reason; for they cause the string to give a quicker start.

182. In the straining of a string, the further it is strained the less superstraining goeth to a note; for it requireth good winding of a string before it will make any note at all: and in the stops of lutes, &c., the higher they go, the less distance is between the frets.

183. If you fill a drinking-glass with water (especially one sharp below, and wide above), and fillip upon the brim or outside; and after empty part of the water, and so more and more, and still try the tone by filliping; you shall find the tone fall and be more base, as the glass is more empty.

[1] Arist. Prob. xi. 16. 34. and 62.

Experiments in consort touching the proportion of treble and base tones.

The just and measured proportion of the air percussed, towards the baseness or trebleness of tones, is one of the greatest secrets in the contemplation of sounds. For it discovereth the true coincidence of tones into diapasons; which is the return of the same sound. And so of the concords and discords between the unison and diapason; which we have touched before in the experiments of music; but think fit to resume it here as a principal part of our inquiry touching the nature of sounds. It may be found out in the proportion of the winding of strings; in the proportion of the distance of frets; and in the proportion of the concave of pipes, &c., but most commodiously in the last of these.

184. Try therefore the winding of a string once about, as soon as it is brought to that extension as will give a tone: and then of twice about, and thrice about, &c.; and mark the scale or difference of the rise of the tone: whereby you shall discover, in one, two effects; both the proportion of the sound towards the dimension of the winding; and the proportion likewise of the sound towards the string, as it is more or less strained. But note that to measure this, the way will be to take the length in a right line of the string, upon any winding about of the peg.

185. As for the stops, you are to take the number of frets; and principally the length of the line, from the first stop of the string, unto such a stop as shall produce a diapason to the former stop upon the same string.

186. But it will best (as it is said) appear in the bores of wind-instruments: and therefore cause some half dozen pipes to be made, in length and all things else alike, with a single, double, and so on to a sextuple bore; and so mark what fall of tone every one giveth. But still in these three last instances, you must diligently observe what length of string, or distance of stop, or concave of air, maketh what rise of sound. As in the last of these, which (as we said) is that which giveth the aptest demonstration, you must set down what increase of concave goeth to the making of a note higher; and what of two notes; and what of three notes; and so up to the diapason: for then the great secret of numbers and proportions will ap-

pear. It is not unlike that those that make recorders, &c., know this already: for that they make them in sets: and likewise, bell-founders, in fitting the tune of their bells. So that inquiry may save trial. Surely it hath been observed by one of the ancients, that an empty barrel knocked upon with the finger, giveth a diapason to the sound of the like barrel full[1]; but how that should be I do not well understand; for that the knocking of a barrel, full or empty, doth scarce give any tone.

187. There is required some sensible difference in the proportion of creating a note, towards the sound itself, which is the passive: and that it be not too near, but at a distance. For in a recorder, the three uppermost holes yield one tone; which is a note lower than the tone of the first three. And the like (no doubt) is required in the winding or stopping of strings.

Experiments in consort touching exterior and interior sounds.

There is another difference of sounds, which we will call exterior and interior. It is not soft nor loud: nor it is not base nor treble: nor it is not musical nor immusical: though it be true, that there can be no tone in an interior sound; but on the other side, in an exterior sound there may be both musical and immusical. We shall therefore enumerate them, rather than precisely distinguish them; though (to make some adumbration of what we mean) the interior is rather an impulsion or contusion of the air, than an elision or section of the same: so as the percussion of the one, towards the other, differeth as a blow differeth from a cut.

188. In speech of man, the whispering (which they call *susurrus* in Latin), whether it be louder or softer, is an interior sound; but the speaking out is an exterior sound[2]; and therefore you can never make a tone nor sing in whispering; but in speech you may. So breathing, or blowing

[1] Aristotle says that if of two equal vessels one is empty and the other half full, the note given by the latter will be an octave above that given by the former. See Prob. xix. 50. He gives the right explanation, that the case is analogous to that of two pipes, the length of one of which is twice that of the other. It is singular that Bacon appears to have been ignorant of the theory of the monochord, or that he here proposes as a subject of inquiry what was familiarly known to the Greeks.

[2] Similarly Aristotle remarks that the noise emitted by an elephant through the mouth is analogous to sighing or groaning, but that, by means of the trunk, it can produce a sound resembling that of a trumpet.

by the mouth, bellows, or wind, (though loud,) is an interior sound; but the blowing through a pipe or concave, (though soft,) is an exterior. So likewise the greatest winds, if they have no coarctation, or blow not hollow, give an interior sound; the whistling or hollow wind yieldeth a singing or exterior sound; the former being pent by some other body; the latter being pent in by his own density: and therefore we see, that when the wind bloweth hollow, it is a sign of rain. The flame, as it moveth within itself or is blown by a bellows, giveth a murmur or interior sound.

189. There is no hard body, but struck against another hard body, will yield an exterior sound, greater or lesser: insomuch as if the percussion be over-soft, it may induce a nullity of sound; but never an interior sound; as when one treadeth so softly that he is not heard.

190. Where the air is the percutient, pent or not pent, against a hard body, it never giveth an exterior sound; as if you blow strongly with a bellows against a wall.

191. Sounds (both exterior and interior) may be made as well by suction as by the emission of the breath: as in whistling or breathing.

Experiments in consort touching articulation of sounds.

192. It is evident, and it is one of the strangest secrets in sounds, that the whole sound is not in the whole air only; but the whole sound is also in every small part of the air. So that all the curious diversity of articulate sounds, of the voice of man or birds, will enter into a small cranny inconfused.

193. The unequal agitation of the winds and the like, though they be material to the carriage of the sounds further or less way, yet they do not confound the articulation of them at all, within that distance that they can be heard; though it may be, they make them to be heard less way than in a still; as hath been partly touched.

194. Over-great distance confoundeth the articulation of sounds; as we see that you may hear the sound of a preacher's voice, or the like, when you cannot distinguish what he saith. And one articulate sound will confound another; as when many speak at once.

195. In the experiment of speaking under water, when the voice is reduced to such an extreme exility, yet the articulate

sounds (which are the words) are not confounded; as hath been said.

196. I conceive that an extreme small or an extreme great sound cannot be articulate; but that the articulation requireth a mediocrity of sound: for that the extreme small sound confoundeth the articulation by contracting: and the great sound by dispersing: and although (as was formerly said) a sound articulate, already created, will be contracted into a small cranny; yet the first articulation requireth more dimension.

197. It hath been observed, that in a room or in a chapel vaulted below and vaulted likewise in the roof, a preacher cannot be heard so well, as in the like places not so vaulted. The cause is, for that the subsequent words come on before the precedent words vanish; and therefore the articulate sounds are more confused, though the gross of the sound be greater.

198. The motions of the tongue, lips, throat, palate, &c., which go to the making of the several alphabetical letters, are worthy inquiry, and pertinent to the present inquisition of sounds: but because they are subtile, and long to describe, we will refer them over, and place them amongst the experiments of speech. The Hebrews have been diligent in it, and have assigned which letters are labial, which dental, which guttural, &c. As for the Latins and Grecians, they have distinguished between semi-vowels and mutes, and in mutes between *mutæ tenues, mediæ,* and *aspiratæ,* not amiss, but yet not diligently enough. For the special strokes and motions that create those sounds, they have little inquired[1]: as, that the letters *B, P, F, M,* are not expressed but with the contracting or shutting of the mouth; that the letters *N* and *B,* cannot be pronounced but that the letter *N* will turn into *M;* as *hecatonba* will be *hecatomba.* That *M* and *T* cannot be pronounced together but *P* will come between; as *emtus* is pronounced *emptus;* and a number of the like.[2] So that if you inquire to the full, you will find that to the making of the whole alphabet there will be fewer simple motions required than there are letters.

[1] Notice however the interesting remark of Nigidius preserved by Aulus Gellius, xix. 14., that *N G* [or rather the sound of *N* when immediately followed by *G*], is not a true *N, sed adulterinum;* the test being that in pronouncing such words as *anguis, angaria, increpat,* and the like, the tip of the tongue does not touch the palate. I believe I have given the sense of the remark correctly. It appears to show that our way of pronouncing such words is erroneous. We ought to divide the syllables after the second consonant. [One of the instances given is *ingenuus,* from which we may certainly infer that in Nigidius's time the *G* in that word was pronounced hard.—*J. S.*]

[2] Compare Latham, *The English Language,* § 109.

199. The lungs are the most spongy part of the body; and therefore ablest to contract and dilate itself[1]; and where it contracteth itself, it expelleth the air; which through the artire[2], throat, and mouth, maketh the voice: but yet articulation is not made but with the help of the tongue, palate, and the rest of those they call instruments of voice.

200. There is found a similitude between the sound that is made by inanimate bodies, or by animate bodies that have no voice articulate, and divers letters of articulate voices: and commonly men have given such names to those sounds, as do allude unto the articulate letters. As trembling of water hath resemblance with the letter *L*; quenching of hot metals with the letter *Z*; snarling of dogs with the letter *R*; the noise of scrich-owls with the letters *Sh*; voice of cats with the diphthong *Eu*; voice of cuckows with the diphthong *Ou*[3]; sounds of strings with the letters *Ng*; so that if a man (for curiosity or strangeness sake) would make a puppet or other dead body to pronounce a word, let him consider, on the one part, the motion of the instruments of voice; and on the other part, the like sounds made in inanimate bodies; and what conformity there is that causeth the similitude of sounds; and by that he may minister light to that effect.

[1] The contraction and dilatation of the lungs is merely passive, and caused by the action of the diaphragm and abdominal muscles.

[2] So in the original. I suppose the *aspera arteria*, or wind-pipe, is meant. See note 3. p. 406.—*J. S.*

[3] From this it would seem that in Bacon's time the letters *ou*, were used to describe the sound which we should now describe by *oo*; whence we must further infer that a large number of words were then pronounced as they are now in Scotland and the north of England.—*J. S.*

NATURAL HISTORY.

CENTURY III.

Experiments in consort touching the motions of sounds, in what lines they are; circular, oblique, straight; upwards, downwards; forwards, backwards.

201. ALL sounds whatsoever move round; that is to say, on all sides; upwards, downwards, forwards, and backwards. This appeareth in all instances.

202. Sounds do not require to be conveyed to the sense in a right line, as visibles do, but may be arched; though it be true, they move strongest in a right line; which nevertheless is not caused by the rightness of the line, but by the shortness of the distance. *Linea recta brevissima.* And therefore we see, if a wall be between, and you speak on the one side, you hear it on the other; which is not because the sound passeth through the wall, but archeth over the wall.

203. If the sound be stopped and repercussed, it cometh about on the other side in an oblique line. So, if in a coach one side of the boot be down and the other up, and a beggar beg on the close side, you would think that he were on the open side. So likewise, if a bell or clock be (for example) on the north side of a chamber, and the window of that chamber be upon the south, he that is in the chamber will think the sound came from the south.

204. Sounds, though they spread round, (so that there is an orb or spherical area of the sound,) yet they move strongest and go furthest in the fore-lines, from the first local impulsion of the air. And therefore in preaching, you shall hear the preacher's voice better before the pulpit than behind it or on

the sides, though it stand open. So a harquebuss or ordnance will be further heard forwards from the mouth of the piece, than backwards or on the sides.

205. It may be doubted, that sounds do move better downwards than upwards.[1] Pulpits are placed high above the people. And when the ancient generals spake to their armies, they had ever a mount of turf cast up, whereupon they stood. But this may be imputed to the stops and obstacles which the voice meeteth with, when one speaketh upon the level. But there seemeth to be more in it; for it may be that spiritual species, both of things visible and sounds, do move better downwards than upwards. It is a strange thing, that to men standing below on the ground, those that be on the top of Paul's seem much less than they are, and cannot be known: but to men above, those below seem nothing so much lessened, and may be known: yet it is true, that all things to them above seem also somewhat contracted, and better collected into figure: as knots in gardens shew best from an upper-window or terrace.

206. But to make an exact trial of it, let a man stand in a chamber not much above the ground, and speak out at the window, through a trunk, to one standing on the ground, as softly as he can, the other laying his ear close to the trunk; then *via versa*, let the other speak below, keeping the same proportion of softness; and let him in the chamber lay his ear to the trunk: and this may be the aptest means to make a judgment whether sounds descend or ascend better.

Experiments in consort touching the lasting and perishing of sounds; and touching the time they require to their generation or delation.

207. After that sound is created (which is in a moment), we find it continueth some small time, melting by little and little. In this there is a wonderful error amongst men, who take this to be a continuance of the first sound; whereas (in truth) it is a renovation, and not a continuance; for the body percussed hath, by reason of the percussion, a trepidation wrought in the minute parts; and so reneweth the percussion of the air. This appeareth manifestly, because that the melting sound of a bell

[1] Aristotle asserts that they do. Prob. xi. 45.

or of a string strucken, which is thought to be a continuance, ceaseth as soon as the bell or string are touched. As in a virginal, as soon as ever the jack falleth and toucheth the string, the sound ceaseth; and in a bell, after you have chimed upon it, if you touch the bell the sound ceaseth. And in this you must distinguish that there are two trepidations: the one manifest and local; as of the bell when it is pensile: the other secret, of the minute parts; such as is described in the ninth instance. But it is true, that the local helpeth the secret greatly. We see likewise that in pipes, and other wind instruments, the sound lasteth no longer than the breath bloweth. It is true, that in organs there is a confused murmur for a while after you have played; but that is but while the bellows are in falling.

208. It is certain, that in the noise of great ordnance, where many are shot off together, the sound will be carried (at the least) twenty miles upon the land, and much further upon the water.[1] But then it will come to the ear, not in the instant of the shooting off, but it will come an hour or more later. This must needs be a continuance of the first sound; for there is no trepidation which should renew it. And the touching of the ordnance would not extinguish the sound the sooner: so that in great sounds the continuance is more than momentany.

209. To try exactly the time wherein sound is delated, let a man stand in a steeple, and have with him a taper; and let some veil be put before the taper; and let another man stand in the field a mile off. Then let him in the steeple strike the bell, and in the same instant withdraw the veil; and so let him in the field tell by his pulse what distance of time there is between the light seen, and the sound heard: for it is certain that the delation of light is in an instant. This may be tried in far greater distances, allowing greater lights and sounds.

210. It is generally known and observed that light, and the object of sight, move swifter than sound: for we see the flash of a piece is seen sooner than the noise is heard. And in hewing wood, if one be some distance off, he shall see the arm lifted up for a second stroke, before he hear the noise of the first. And the greater the distance, the greater is the prevention: as

[1] It is said that a cannonade has been heard 180 or 200 miles off, and it is particularly mentioned that during the sea fight with the Dutch in 1672 the firing was heard at Shrewsbury. But it may be doubted whether this be true.

we see in thunder which is far off, where the lightning precedeth the crack a good space.

211. Colours when they represent themselves to the eye, fade not, nor melt not by degrees, but appear still in the same strength; but sounds melt and vanish by little and little. The cause is, for that colours participate nothing with the motion of the air, but sounds do. And it is a plain argument, that sound participateth of some local motion of the air (as a cause *sine qua non*), in that it perisheth so suddenly; for in every section or impulsion of the air, the air doth suddenly restore and reunite itself; which the water also doth, but nothing so swiftly.

Experiments in consort touching the passage and interceptions of sounds.

In the trials of the passage or not passage of sounds, you must take heed you mistake not the passing by the sides of a body for the passing through a body; and therefore you must make the intercepting body very close; for sound will pass through a small chink.

212. Where sound passeth through a hard or close body, (as through water; through a wall; through metal, as in hawks' bells stopped, &c.), the hard or close body must be but thin and small; for else it deadeth and extinguisheth the sound utterly. And therefore in the experiment of speaking in air under water, the voice must not be very deep within the water: for then the sound pierceth not. So if you speak on the further side of a close wall, if the wall be very thick you shall not be heard; and if there were an hogshead empty, whereof the sides were some two foot thick, and the bunghole stopped, I conceive the resounding sound, by the communication of the outward air with the air within, would be little or none: but only you shall hear the noise of the outward knock, as if the vessel were full.

213. It is certain, that in the passage of sounds through hard bodies the spirit or pneumatical part of the hard body itself doth co-operate; but much better when the sides of that hard body are struck, than when the percussion is only within, without touch of the sides. Take therefore a hawk's bell, the holes stopped up, and hang it by a thread within a bottle glass, and stop the mouth of the glass very close with wax; and then

shake the glass, and see whether the bell give any sound at all, or how weak. But note, that you must instead of the thread take a wire; or else let the glass have a great belly; lest when you shake the bell, it dash upon the sides of the glass.

214. It is plain, that a very long and downright arch for the sound to pass, will extinguish the sound quite; so that that sound which would be heard over a wall, will not be heard over a church; nor that sound which will be heard if you stand some distance from the wall, will be heard if you stand close under the wall.

215. Soft and foraminous bodies, in the first creation of the sound, will dead it; for the striking against cloth or fur will make little sound; as hath been said: but in the passage of the sound, they will admit it better than harder bodies; as we see that curtains and hangings will not stay the sound much; but glass windows, if they be very close, will check a sound more than the like thickness of cloth. We see also in the rumbling of the belly, how easily the sound passeth through the guts and skin.

216. It is worthy the inquiry, whether great sounds (as of ordnance or bells) become not more weak and exile when they pass through small crannies. For the subtilties of articulate sounds (it may be) may pass through small cranies not confused, but the magnitude of the sound (perhaps) not so well.

Experiments in consort touching the medium of sounds.

217. The mediums of sounds are, air; soft and porous bodies; also water. And hard bodies refuse not altogether to be mediums of sounds. But all of them are dull and unapt deferents, except the air.

218. In air, the thinner or drier air carrieth not the sound so well as the more dense; as appeareth in night sounds, and evening sounds, and sounds in moist weather and southern winds. The reason is already mentioned in the title of majoration of sounds; being for that thin air is better pierced; but thick air preserveth the sound better from waste. Let further trial be made by hollowing in mists and gentle showers; for (it may be) that will somewhat dead the sound.

219. How far forth flame may be a medium of sounds, (especially of such sounds as are created by air, and not betwixt hard bodies,) let it be tried in speaking where a bonfire is

between; but then you must allow, for some disturbance, the noise that the flame itself maketh.

220. Whether any other liquors, being made mediums, cause a diversity of sound from water, it may be tried: as by the knapping of the tongs; or striking of the bottom of a vessel, filled either with milk or with oil; which though they be more light, yet are they more unequal bodies than air.

Of the natures of the mediums we have now spoken; as for the disposition of the said mediums, it doth consist in the penning, or not penning of the air; of which we have spoken before in the title of delation of sounds: it consisteth also in the figure of the concave through which it passeth; of which we will speak next.

Experiments in consort, what the figures of the pipes, or concaves, or the bodies deferent, conduce to the sounds.

How the figures of pipes, or concaves, through which sounds pass, or of other bodies deferent, conduce to the variety and alteration of the sounds; either in respect of the greater quantity or less quantity of air which the concaves receive, or in respect of the carrying of sounds longer or shorter way, or in respect of many other circumstances; they have been touched, as falling into other titles. But those figures which we are now to speak of, we intend to be as they concern the lines through which the sound passeth; as straight, crooked, angular, circular, &c.

221. The figure of a bell partaketh of the pyramis, but yet coming off and dilating more suddenly. The figure of a hunter's horn and cornet is oblique; yet they have likewise straight horns; which, if they be of the same bore with the oblique, differ little in sound, save that the straight require somewhat a stronger blast. The figures of recorders, and flutes, and pipes, are straight; but the recorder hath a less bore and a greater; above and below. The trumpet hath the figure of the letter *S:* which maketh that purling sound, &c. Generally the straight line hath the cleanest and roundest sound, and the crooked the more hoarse and jarring.

222. Of a sinuous pipe, that may have some four flexions, trial would be made. Likewise of a pipe made like a cross, open in the midst. And so likewise of an angular pipe. And

see what will be the effects of these several sounds. And so again of a circular pipe; as if you take a pipe perfect round, and make a hole whereinto you shall blow, and another hole not far from that; but with a traverse or stop between them; so that your breath may go the round of the circle, and come forth at the second hole. You may try likewise percussions of solid bodies of several figures; as globes, flats, cubes, crosses, triangles, &c.; and their combinations, as flat against flat, and convex against convex, and convex against flat, &c.; and mark well the diversities of the sounds. Try also the difference in sound of several crassitudes of hard bodies percussed; and take knowledge of the diversities of the sounds. I myself have tried, that a bell of gold yieldeth an excellent sound, not inferior to that of silver or brass, but rather better: yet we see that a piece of money of gold soundeth far more flat than a piece of money of silver.

223. The harp hath the concave, not along the strings, but across the strings; and no instrument hath the sound so melting and prolonged as the Irish harp. So as I suppose that if a virginal were made with a double concave; the one all the length, as the virginal hath; the other at the end of the strings, as the harp hath; it must needs make the sound perfecter, and not so shallow and jarring. You may try it without any sound-board along, but only harp-wise at one end of the strings; or lastly, with a double concave, at each end of the strings one.

Experiments in consort touching the mixture of sounds.

224. There is an apparent diversity between the species visible and audible in this, that the visible doth not mingle in the medium, but the audible doth. For if we look abroad, we see heaven, a number of stars, trees, hills, men, beasts, at once. And the species of the one doth not confound the other. But if so many sounds come from several parts, one of them would utterly confound the other. So we see that voices or consorts of music do make an harmony by mixture, which colours do not. It is true nevertheless that a great light drowneth a smaller, that it cannot be seen; as the sun that of a glow-worm; as well as a great sound drowneth a lesser. And I suppose likewise, that if there were two lanthorns of glass, the one a crimson, and the other an azure, and a candle within

either of them, those coloured lights would mingle, and cast upon a white paper a purple colour. And even in colours, they yield a faint and weak mixture: for white walls make rooms more lightsome than black, &c. But the cause of the confusion in sounds and the inconfusion in species visible is, for that the sight worketh in right lines, and maketh several cones; and so there can be no coincidence in the eye or visual point: but sounds, that move in oblique and arcuate lines, must needs encounter and disturb the one the other.

225. The sweetest and best harmony is, when every part or instrument is not heard by itself, but a conflation of them all; which requireth to stand some distance off. Even as it is in the mixture of perfumes; or the taking of the smells of several flowers in the air.

226. The disposition of the air in other qualities, except it be joined with sound, hath no great operation upon sounds: for whether the air be lightsome or dark, hot or cold, quiet or stirring (except it be with noise), sweet-smelling or stinking, or the like; it importeth not much. Some petty alteration or difference it may make.

227. But sounds do disturb and alter the one the other: sometimes the one drowning the other, and making it not heard; sometimes the one jarring and discording with the other, and making a confusion; sometimes the one mingling and compounding with the other, and making an harmony.

228. Two voices of like loudness will not be heard twice as far as one of them alone[1]: and two candles of like light, will not make things seen twice as far off as one. The cause is profound; but it seemeth that the impressions from the objects of the senses do mingle respectively, every one with his kind: but not in proportion, as is before demonstrated: and the reason may be, because the first impression, which is from privative to active, (as from silence to noise, or from darkness to light,) is a greater degree than from less noise to more noise, or from less light to more light. And the reason of that again may be, for that the air, after it hath received a charge, doth not receive a surcharge, or greater charge, with like appetite as it doth the first charge. As for the increase of virtue, generally, what proportion it beareth to the increase of the matter, it is a large field, and to be handled by itself.

[1] Arist. Prob. xi. 52.

Experiments in consort touching melioration of sounds.

229. All reflexions concurrent do make sounds greater; but if the body that createth either the original sound or the reflexion be clean and smooth, it maketh them sweeter. Trial may be made of a lute or viol, with the belly of polished brass instead of wood. We see that even in the open air, the wire-string is sweeter than the string of guts. And we see that for reflexion water excelleth; as in music near the water, or in echoes.

230. It hath been tried, that a pipe a little moistened on the inside, but yet so as there be no drops left, maketh a more solemn sound than if the pipe were dry: but yet with a sweet degree of sibilation or purling; as we touched it before in the title of equality. The cause is, for that all things porous being superficially wet, and (as it were) between dry and wet, become a little more even and smooth; but the purling (which must needs proceed of inequality) I take to be bred between the smoothness of the inward surface of the pipe, which is wet, and the rest of the wood of the pipe, unto which the wet cometh not, but it remaineth dry.

231. In frosty weather music within doors soundeth better. Which may be by reason, not of the disposition of the air, but of the wood or string of the instrument, which is made more crisp, and so more porous and hollow: and we see that old lutes sound better than new for the same reason. And so do lute-strings that have been kept long.

232. Sound is likewise meliorated by the mingling of open air with pent air; therefore trial may be made of a lute or viol with a double belly; making another belly with a knot over the strings; yet so as there be room enough for the strings, and room enough to play below that belly. Trial may be also made of an Irish harp, with a concave on both sides; whereas it useth to have it but on one side. The doubt may be, lest it should make too much resounding, whereby one note would overtake another.

233. If you sing into the hole of a drum, it maketh the singing more sweet. And so I conceive it would, if it were a song in parts, sung into several drums; and for handsomeness and strangeness sake, it would not be amiss to have a curtain between the place where the drums are and the hearers.

234. When a sound is created in a wind-instrument between the breath and the air, yet if the sound be communicate with a more equal body of the pipe, it meliorateth the sound. For no doubt there would be a differing sound in a trumpet or pipe of wood, and again in a trumpet or pipe of brass. It were good to try recorders and hunters' horns of brass, what the sound would be.

235. Sounds are meliorated by the intension of the sense; where the common sense is collected most to the particular sense of hearing, and the sight suspended: and therefore sounds are sweeter (as well as greater) in the night than in the day; and I suppose they are sweeter to blind men than to others: and it is manifest, that between sleeping and waking, (when all the senses are bound and suspended,) music is far sweeter than when one is fully waking.

Experiments in consort touching the imitation of sounds.

236. It is a thing strange in nature, when it is attentively considered, how children, and some birds, learn to imitate speech. They take no mark at all of the motion of the mouth of him that speaketh; for birds are as well taught in the dark as by light. The sounds of speech are very curious and exquisite: so one would think it were a lesson hard to learn. It is true that it is done with time, and by little and little, and with many essays and proffers: but all this dischargeth not the wonder. It would make a man think (though this which we shall say may seem exceeding strange) that there is some transmission of spirits; and that the spirit of the teacher put in motion, should work with the spirits of the learner a predisposition to offer to imitate; and so to perfect the imitation by degrees. But touching operations by transmissions of spirits, (which is one of the highest secrets in nature,) we shall speak in due place; chiefly when we come to inquire of imagination. But as for imitation, it is certain that there is in men and other creatures a pre-disposition to imitate. We see how ready apes and monkeys are to imitate all motions of man; and in the catching of dottrels, we see how the foolish bird playeth the ape in gestures: and no man (in effect) doth accompany with others, but he learneth (ere he is aware) some gesture or voice or fashion of the other.

237. In imitation of sounds, that man should be the teacher is no part of the matter; for birds will learn one of another; and there is no reward, by feeding or the like, given them for the imitation; and besides, you shall have parrots that will not only imitate voices, but laughing, knocking, squeaking of a door upon the hinges, or of a cart-wheel; and (in effect) any other noise they hear.

238. No beast can imitate the speech of man, but birds only; for the ape itself, that is so ready to imitate otherwise, attaineth not any degree of imitation of speech. It is true that I have known a dog, that if one howled in his ear, he would fall a howling a great while. What should be the aptness of birds, in comparison of beasts, to imitate the speech of man, may be further inquired. We see that beasts have those parts which they count the instruments of speech, (as lips, teeth, &c.,) liker unto man than birds. As for the neck, by which the throat passeth, we see many beasts have it, for the length, as much as birds. What better gorge or artire[1] birds have[2], may be further inquired. The birds that are known to be speakers, are parrots, pies, jays, daws, and ravens; of which, parrots have an adunque bill, but the rest not.

239. But I conceive, that the aptness of birds is not so much in the conformity of the organs of speech, as in their attention. For speech must come by hearing and learning; and birds give more heed and mark sounds more than beasts; because naturally they are more delighted with them and practise them more; as appeareth in their singing. We see also that those that teach birds to sing, do keep them waking to increase their attention.[3] We see also that cock-birds amongst

[1] That is, wind-pipe. See note 2, p. 413.—*J. S.*

[2] It does not appear that in any point of vocal organisation birds bear more resemblance to man than brutes. The characteristic distinction in this respect between birds and mammalia appears to be that in the former class the trachea is the real organ of voice; the air which passes into it from the lungs being set into vibration at the inferior larynx, whereas in the latter the sonorous vibrations commence at the glottis; the trachea, the rings of which are in this class seldom wholly osseous, serving merely to supply air. It is difficult completely to explain the differences in the voice of different birds. Cuvier was of opinion that, especially with regard to the power of imitating sounds, much depends not on the vocal organ, but on instinct. It is worth remarking that birds which have a trumpet-shaped trachea, as for instance the cock, emit sounds which more or less resemble those of that instrument.

[3] Frederick Cuvier has remarked, that when animals have been kept in a state of vigilance, as the means of taming them, they show no signs of anger against the person who, by making a noise, hinders them from sleeping, although the distress that the want of sleep produces is obvious; a curious proof of the narrow limits within which their power of referring a phenomenon to its cause is confined.

singing birds are ever the better singers; which may be because they are more lively and listen more.

240. Labour and intention to imitate voices, doth conduce much to imitation: and therefore we see that there be certain *pantomimi*, that will represent the voices of players of interludes so to life, as if you see them not you would think they were those players themselves; and so the voices of other men that they hear.

241. There have been some that could counterfeit the distance of voices (which is a secondary object of hearing) in such sort, as when they stand fast by you, you would think the speech came from afar off, in a fearful manner. How this is done may be further inquired. But I see no great use of it but for imposture, in counterfeiting ghosts or spirits.

Experiments in consort touching the reflexion of sounds.

There be three kinds of reflexions of sounds; a reflexion concurrent; a reflexion iterant, which we call echo; and a super-reflexion, or an echo of an echo; whereof the first hath been handled in the title of magnitude of sounds: the latter two we will now speak of.

242. The reflexion of species visible, by mirrors, you may command; because passing in right lines, they may be guided to any point: but the reflexion of sounds is hard to master; because the sound filling great spaces in arched lines, cannot be so guided: and therefore we see there hath not been practised any means to make artificial echoes. And no echo already known returneth in a very narrow room.

243. The natural echoes are made upon walls, woods, rocks, hills, and banks; as for waters, being near, they make a concurrent echo; but being further off, (as upon a large river,) they make an iterant echo: for there is no difference between the concurrent echo and the iterant, but the quickness or slowness of the return. But there is no doubt but water doth help the delation of echo, as well as it helpeth the delation of original sounds.

244. It is certain, (as hath been formerly touched,) that if you speak through a trunk stopped at the further end, you shall find a blast return upon your mouth, but no sound at all. The cause is, for that the closeness, which preserveth the original

is not able to preserve the reflected sound: besides that echoes are seldom created but by loud sounds. And therefore there is less hope of artificial echoes in air pent in a narrow concave. Nevertheless it hath been tried, that one leaning over a well of twenty-five fathom deep, and speaking, though but softly, (yet not so soft as a whisper,) the water returned a good audible echo. It would be tried, whether speaking in caves, where there is no issue save where you speak, will not yield echoes, as wells do.

245. The echo cometh as the original sound doth, in a round orb of air: it were good to try the creating of the echo where the body repercussing maketh an angle: as against the return of a wall, &c. Also we see that in mirrors there is the like angle of incidence, from the object to the glass, and from the glass to the eye. And if you strike a ball side-long, not full upon the surface, the rebound will be as much the contrary way. Whether there be any such resilience in echoes, (that is, whether a man shall hear better if he stand aside the body repercussing, than if he stand where he speaketh, or anywhere in a right line between,) may be tried. Trial likewise would be made, by standing nearer the place of repercussing than he that speaketh; and again by standing further off than he that speaketh; and so knowledge would be taken, whether echoes, as well as original sounds, be not strongest near hand.

246. There be many places where you shall hear a number of echoes one after another: and it is when there is variety of hills or woods, some nearer, some further off: so that the return from the further, being last created, will be likewise last heard.

247. As the voice goeth round, as well towards the back as towards the front of him that speaketh; so likewise doth the echo: for you have many back-echoes to the place where you stand.

248. To make an echo that will report three, or four, or five words distinctly, it is requisite that the body repercussing be a good distance off: for if it be near, and yet not so near as to make a concurrent echo, it choppeth with you upon the sudden. It is requisite likewise that the air be not much pent: for air at a great distance pent, worketh the same effect with air at large in a small distance. And therefore in the trial of speak-

ing in the well, though the well was deep, the voice came back suddenly, and would bear the report but of two words.

249. For echoes upon echoes, there is a rare instance thereof in a place which I will now exactly describe. It is some three or four miles from Paris, near a town called Pont-Charenton; and some bird-bolt shot or more from the river of Seine.[1] The room is a chapel or small church. The walls all standing, both at the sides and at the ends. Two rows of pillars, after the manner of aisles[2] of churches, also standing; the roof all open, not so much as any embowment near any of the walls left. There was against every pillar a stack of billets above a man's height; which the watermen that bring wood down the Seine in stacks, and not in boats, laid there (as it seemeth) for their ease. Speaking at the one end, I did hear it return the voice thirteen several times; and I have heard of others, that it would return sixteen times: for I was there about three of the clock in the afternoon; and it is best (as all other echoes are) in the evening. It is manifest that it is not echoes from several places, but a tossing of the voice, as a ball, to and fro; like to reflexions in looking-glasses; where if you place one glass before and another behind, you shall see the glass behind with the image, within the glass before; and again, the glass before in that; and divers such super-reflexions, till the *species speciei* at last die. For it is every return weaker and more shady. In like manner the voice in that chapel createth *speciem speciei*, and maketh succeeding super-reflexions; for it melteth by degrees, and every reflexion is weaker than the former: so that if you speak three words, it will (perhaps) some three times report you the whole three words; and then the two latter words for some times; and then the last word alone for some times; still fading and growing weaker. And whereas in echoes of one return, it is much to hear four or five words; in this echo of so many returns, upon the matter, you hear above twenty words for three.

250. The like echo upon echo, but only with two reports, hath been observed to be, if you stand between a house and a hill, and lure towards the hill. For the house will give a back echo; one taking it from the other, and the latter the weaker.

[1] The church in which this echo was heard was within the precincts of the Carmelite monastery at Charenton. See the *Encycl. Méthodique*, or that of Diderot and d'Alembert, in voc. Charenton.

[2] *Isles* in the original.—*J. S.*

251. There are certain letters that an echo will hardly express: as S for one, especially being principal in a word. I remember well, that when I went to the echo at Pont-Charenton, there was an old Parisian, who took it to be the work of spirits, and of good spirits. For (said he) call *Satan* and the echo will not deliver back the devil's name; but will say, *va t'en;* which is as much in French as *apage* or *avoid.* And thereby I did hap to find that an echo would not return S, being but a hissing and an interior sound.

252. Echoes are some more sudden, and chop again as soon as the voice is delivered; as hath been partly said: others are more deliberate, that is, give more space between the voice and the echo; which is caused by the local nearness or distance: some will report a longer train of words, and some a shorter; some more loud, (full as loud as the original, and sometimes more loud,) and some weaker and fainter.

253. Where echoes come from several parts at the same distance, they must needs make (as it were) a quire of echoes, and so make the report greater, and even a continued echo; which you shall find in some hills that stand encompassed, theatre-like.

254. It doth not yet appear that there is refraction in sounds, as well as in species visible. For I do not think, that if a sound should pass through divers mediums, (as air, cloth, wood,) it would deliver the sound in a differing place from that unto which it is deferred; which is the proper effect of refraction. But majoration, which is also the work of refraction, appeareth plainly in sounds, (as hath been handled at full,) but it is not by diversity of mediums.

Experiments in consort touching the consent and dissent between visibles and audibles.[1]

We have *obiter*, for demonstration's sake, used in divers instances the examples of the sight and things visible, to illustrate the nature of sounds. But we think good now to prosecute that comparison more fully.

[1] See in illustration of this subject Dr. Whewell's *Philosophy of the Inductive Sciences*, iv. 2.

The analogy of sound and light has been recently illustrated by a curious experiment of M. Stendhaus. He has concentrated sound to a focus by means of an acoustic lens formed of carbonic acid gas enclosed in an envelope of collodion.

Consent of visibles and audibles.

255. Both of them spread themselves in round, and fill a whole ficor or orb, unto certain limits; and are carried a great way; and do languish and lessen by degrees, according to the distance of the objects from the sensories.

256. Both of them have the whole species in every small portion of the air, or medium; so as the species do pass through small crannies without confusion: as we see ordinarily in levels, as to the eye; and in crannies or chinks, as to the sound.

257. Both of them are of a sudden and easy generation and delation; and likewise perish swiftly and suddenly; as if you remove the light, or touch the bodies that give the sound.

258. Both of them do receive and carry exquisite and accurate differences; as of colours, figures, motions, distances, in visibles; and of articulate voices, tones, songs, and quaverings, in audibles.

259. Both of them, in their virtue and working, do not appear to emit any corporal substance into their mediums, or the orb of their virtue: neither again to raise or stir any evident local motion in their mediums as they pass; but only to carry certain spiritual species; the perfect knowledge of the cause whereof, being hitherto scarcely attained, we shall search and handle in due place.

260. Both of them seem not to generate or produce any other effect in nature, but such as appertaineth to their proper objects and senses, and are otherwise barren.

261. But both of them, in their own proper action, do work three manifest effects. The first, in that the stronger species drowneth the lesser; as the light of the sun, the light of a glow-worm; the report of an ordnance, the voice: The second, in that an object of surcharge or excess destroyeth the sense; as the light of the sun the eye; a violent sound (near the ear) the hearing: The third, in that both of them will be reverberate; as in mirrors, and in echoes.

262. Neither of them doth destroy or hinder the species of the other, although they encounter in the same medium; as light or colour hinder not sound, nor *e contra*.

263. Both of them affect the sense in living creatures, and yield objects of pleasure and dislike: yet nevertheless the objects of them do also (if it be well observed) affect and work upon dead things; namely, such as have some conformity with

the organs of the two senses; as visibles work upon a looking-glass, which is like the pupil of the eye; and audibles upon the places of echo, which resemble in some sort the cavern and structure of the ear.

264. Both of them do diversly work, as they have their medium diversly disposed. So a trembling medium (as smoke) maketh the object seem to tremble; and a rising or falling medium (as winds) maketh the sounds to rise or fall.

265. To both, the medium which is the most propitious and conducible, is air; for glass or water, &c., are not comparable.

266. In both of them, where the object is fine and accurate, it conduceth much to have the sense intentive and erect; insomuch as you contract your eye when you would see sharply; and erect your ear when you would hear attentively; which in beasts that have ears moveable is most manifest.

267. The beams of light, when they are multiplied and conglomerate, generate heat; which is a different action from the action of sight: and the multiplication and conglomeration of sounds doth generate an extreme rarefaction of the air; which is an action materiate, differing from the action of sound; if it be true (which is anciently reported) that birds with great shouts have fallen down.

Dissents of visibles and audibles.

268. The species of visibles seem to be emissions of beams from the objects seen; almost like odours; save that they are more incorporeal: but the species of audibles seem to participate more with local motion, like percussions or impressions made upon the air. So that whereas all bodies do seem to work in two manners; either by the communication of their natures, or by the impressions and signatures of their motions; the diffusion of species visible seemeth to participate more of the former operation, and the species audible of the latter.

269. The species of audibles seem to be carried more manifestly through the air than the species of visibles: for I conceive that a contrary strong wind will not much hinder the sight of visibles, as it will do the hearing of sounds.

270. There is one difference above all others between visibles and audibles, that is the most remarkable, as that

whereupon many smaller differences do depend: namely, that visibles (except lights) are carried in right lines, and audibles in arcuate lines.[1] Hence it cometh to pass that visibles do not intermingle and confound one another, as hath been said before; but sounds do. Hence it cometh that the solidity of bodies doth not much hinder the sight, so that the bodies be clear, and the pores in a right line, as in glass, crystal, diamonds, water, &c.; but a thin scarf or handkerchief, though they be bodies nothing so solid, hinder the sight: whereas (contrariwise) these porous bodies do not much hinder the hearing, but solid bodies do almost stop it, or at least attenuate it. Hence also it cometh that to the reflexion of visibles small glasses suffice; but to the reverberation of audibles are required greater spaces, as hath likewise been said before.

271. Visibles are seen further off than sounds are heard; allowing nevertheless the rate of their bigness; for otherwise a great sound will be heard further off than a small body seen.

272. Visibles require (generally) some distance between the object and the eye, to be better seen; whereas in audibles, the nearer the approach of the sound is to the sense the better. But in this there may be a double error. The one because to seeing there is required light; and any thing that toucheth the pupil of the eye (all over) excludeth the light. For I have heard of a person very credible, (who himself was cured of a cataract in one of his eyes,) that while the silver needle did work upon the sight of his eye to remove the film of the cataract, he never saw any thing more clear or perfect than that white needle: which (no doubt) was because the needle was lesser than the pupil of the eye, and so took not the light from it. The other error may be, for that the object of sight doth strike upon the pupil of the eye directly, without any interception; whereas the cave of the ear doth hold off the sound a little from the organ: and so nevertheless there is some distance required in both.

273. Visibles are swiftlier carried to the sense than audibles; as appeareth in thunder and lightning, flame and report of a

[1] Arist. Prob. xi. 49. and 58.; and xxv. 9. Aristotle explains the passage of light through transparent bodies as Bacon does. The latter's statement of the difference between sound and light is, as the phenomenon of diffraction shows, not strictly accurate. Both have in some degree the power of passing round the edges or corners of obstacles.

piece, motion of the air in hewing of wood. All which have been set down heretofore, but are proper for this title.

274. I conceive also that the species of audibles do hang longer in the air than those of visibles: for although even those of visibles do hang some time, as we see in rings turned, that show like spheres; in lute-strings fillipped; a fire-brand carried along, which leaveth a train of light behind it; and in the twi-light, and the like; yet I conceive that sounds stay longer, because they are carried up and down with the wind; and because of the distance of the time in ordnance discharged, and heard twenty miles off.

275. In visibles there are not found objects so odious and ingrate to the sense as in audibles. For foul sights do rather displease in that they excite the memory of foul things, than in the immediate objects. And therefore in pictures, those foul sights do not much offend; but in audibles, the grating of a saw, when it is sharpened, doth offend so much, as it setteth the teeth on edge. And any of the harsh discords in music the ear doth straightway refuse.

276. In visibles, after great light, if you come suddenly into the dark, or contrariwise out of the dark into a glaring light, the eye is dazzled for a time, and the sight confused; but whether any such effect be after great sounds, or after a deep silence, may be better inquired. It is an old tradition, that those that dwell near the cataracts of Nilus are strucken deaf[1]; but we find no such effect in cannoniers, nor millers, nor those that dwell upon bridges.

277. It seemeth that the impression of colour is so weak, as it worketh not but by a cone of direct beams, or right lines; whereof the basis is in the object, and the vertical point in the eye; so as there is a corradiation and conjunction of beams; and those beams so sent forth, yet are not of any force to beget the like borrowed or second beams, except it be by reflexion, whereof we speak not. For the beams pass, and give little tincture to that air which is adjacent; which if they did, we should see colours out of a right line. But as this is in colours, so otherwise it is in the body of light. For when there is a skreen between the candle and the eye, yet the light passeth to the paper whereon one writeth; so that the light is seen where the body of the flame is not seen, and where any colour (if it

[1] Pliny, vi. 35. [Cic. Somn. Scip. c. 5.]

were placed where the body of the flame is) would not be seen. I judge that sound is of this latter nature; for when two are placed on both sides of a wall, and the voice is heard, I judge it is not only the original sound, which passeth in an arched line; but the sound which passeth above the wall in a right line, begetteth the like motion round about it as the first did, though more weak.

Experiments in consort touching the sympathy or antipathy of sounds one with another.

278. All concords and discords of music are (no doubt) sympathies and antipathies of sounds. And so likewise in that music which we call broken music, or consort music, some consorts of instruments are sweeter than others (a thing not sufficiently yet observed): as the Irish harp and base viol agree well; the recorder and stringed music agree well; organs and the voice agree well, &c; but the virginals and the lute, or the Welsh harp and Irish harp, or the voice and pipes alone, agree not so well. But for the melioration of music there is yet much left (in this point of exquisite consorts) to try and inquire.

279. There is a common observation, that if a lute or viol be laid upon the back, with a small straw upon one of the strings, and another lute or viol be laid by it; and in the other lute or viol the unison to that string be strucken; it will make the string move; which will appear both to the eye, and by the straw's falling off. The like will be, if the diapason or eighth to that string be strucken, either in the same lute or viol, or in others lying by: but in none of these there is any report of sound, that can be discerned, but only motion.

280. It was devised, that a viol should have a lay of wire-strings below, as close to the belly as a lute; and then the strings of guts mounted upon a bridge, as in ordinary viols; to the end that by this means the upper strings strucken should make the lower resound by sympathy, and so make the music the better; which if it be to purpose, then sympathy worketh as well by report of sound as by motion. But this device I conceive to be of no use; because the upper strings, which are stopped in great variety, cannot maintain a diapason or unison with the lower, which are never stopped. But if it should be of use at all, it must be in instruments which have no stops; as

virginals and harps; wherein trial may be made of two rows of strings, distant the one from the other.

281. The experiment of sympathy may be transferred (perhaps) from instruments of strings to other instruments of sound. As to try, if there were in one steeple two bells of unison, whether the striking of the one would move the other, more than if it were another accord: and so in pipes (if they be of equal bore and sound) whether a little straw or feather would move in the one pipe, when the other is blown at an unison.

282. It seemeth, both in ear and eye, the instrument of sense hath a sympathy or similitude with that which giveth the reflexion, (as hath been touched before); for as the sight of the eye is like a crystal, or glass, or water; so is the ear a sinuous cave, with a hard bone to stop and reverberate the sound; which is like to the places that report echoes.

Experiments in consort touching the hindering or helping of the hearing.

283. When a man yawneth, he cannot hear so well.[1] The cause is, for that the membrane of the ear is extended; and so rather casteth off the sound than draweth it to.

284. We hear better when we hold our breath than contrary; insomuch, as in all listening to attain a sound afar off, men hold their breath. The cause is, for that in all expiration the motion is outwards; and therefore rather driveth away the voice than draweth it: and besides, we see that in all labour to do things with any strength, we hold the breath[2]; and listening after any sound that is heard with difficulty, is a kind of labour.

285. Let it be tried, for the help of the hearing, (and I con-

[1] Aristot. Prob. xi. 29. and 44. The reason appears to be that in the act of yawning, air is forced into the Eustachian tubes and, as Bacon rightly supposes, by increasing the tension of the tympanum diminishes its power of transmitting sound. Savart, who showed that an increase in the tension of a membrane had this effect, was of opinion that the use of the internal muscles of the ear is to increase by the mechanism of the bones the tension of the tympanum, and indirectly that of the membrane which covers the foramen rotundum, and that they are called into action when sounds would otherwise become painfully loud. It seems to me not improbable that the reflex action of these muscles excited by the vibration of the tympanum enters to a certain extent, in all cases, into the mechanism of hearing, and that the nerve is affected not only by the vibration of the surrounding pulp, but also by the varying pressure exercised by the stirrup bone. It is worthy of remark that Aristotle was aware of the existence of the Eustachian tube.

[2] The reason of this however is, that by holding the breath and thus keeping the chest dilated we increase the *purchase* of the muscles of the upper part of the body.

ceive it likely to succeed,) to make an instrument like a tunnel; the narrow part whereof may be of the bigness of the hole of the ear; and the broader end much larger, like a bell at the skirts; and the length half a foot or more. And let the narrow end of it be set close to the ear: and mark whether any sound, abroad in the open air, will not be heard distinctly from further distance than without that instrument; being (as it were) an ear-spectacle. And I have heard there is in Spain an instrument in use to be set to the ear, that helpeth somewhat those that are thick of hearing.[1]

286. If the mouth be shut close, nevertheless there is yielded by the roof of the mouth a murmur, such as is used by dumb men. But if the nostrils be likewise stopped, no such murmur can be made, except it be in the bottom of the palate towards the throat. Whereby it appeareth manifestly, that a sound in the mouth, except such as aforesaid, if the mouth be stopped, passeth from the palate through the nostrils.

Experiments in consort touching the spiritual and fine nature of sounds.

287. The repercussion of sounds (which we call echo) is a great argument of the spiritual essence of sounds. For if it were corporeal, the repercussion should be created in the same manner, and by like instruments, with the original sound; but we see what a number of exquisite instruments must concur in speaking of words, whereof there is no such matter in the returning of them; but only a plain stop and repercussion.

288. The exquisite differences of articulate sounds, carried along in the air, shew that they cannot be signatures or impressions in the air, as hath been well refuted by the ancients.[2] For it is true, that seals make excellent impressions; and so it may be thought of sounds in their first generation; but then the delation and continuance of them without any new sealing, shew apparently they cannot be impressions.

289. All sounds are suddenly made, and do suddenly perish: but neither that, nor the exquisite differences of them, is matter of so great admiration: for the quaverings and warblings

[1] Ear-trumpets are proposed by Porta: see his *Natural Magic*, xx. 5.

[2] Bacon's meaning is not clear, but he seems to allude to the doctrine of the atomists that sound is material, and to Aristotle's dissent from it. The latter, as we see in the *Prob.* xi. 6., and elsewhere, apprehended distinctly the difference between the propagation of sound and the motion of a projectile.

of lutes and pipes are as swift; and the tongue (which is no very fine instrument) doth in speech make no fewer motions than there be letters in all the words which are uttered. But that sounds should not only be so speedily generated, but carried so far every way in such a momentany time, deserveth more admiration. As for example, if a man stand in the middle of a field and speak aloud, he shall be heard a furlong in round; and that shall be in articulate sounds; and those shall be entire in every little portion of the air; and this shall be done in the space of less than a minute.

290. The sudden generation and perishing of sounds must be one of these two ways. Either that the air suffereth some force by sound, and then restoreth itself; as water doth; which being divided, maketh many circles, till it restore itself to the natural consistence: or otherwise, that the air doth willingly imbibe the sound as grateful, but cannot maintain it; for that the air hath (as it should seem) a secret and hidden appetite of receiving the sound at the first; but then other gross and more materiate qualities of the air straightways suffocate it; like unto flame, which is generated with alacrity, but straight quenched by the enmity of the air or other ambient bodies.

There be these differences (in general) by which sounds are divided: 1. Musical, immusical. 2. Treble, base. 3. Flat, sharp. 4. Soft, loud. 5. Exterior, interior. 6. Clean, harsh or purling. 7. Articulate, inarticulate.

We have laboured (as may appear) in this inquisition of sounds diligently; both because sound is one of the most hidden portions of nature, (as we said in the beginning); and because it is a virtue which may be called incorporeal and immateriate; whereof there be in nature but few. Besides, we were willing (now in these our first centuries) to make a pattern or precedent of an exact inquisition; and we shall do the like hereafter in some other subjects which require it. For we desire that men should learn and perceive, how severe a thing the true inquisition of nature is; and should accustom themselves, by the light of particulars, to enlarge their minds to the amplitude of the world; and not to reduce the world to the narrowness of their minds.

Experiment solitary touching the orient colours in dissolution of metals.

291. Metals give orient and fine colours in dissolutions; as gold giveth an excellent yellow, quicksilver an excellent green, tin giveth an excellent azure: likewise in their putrefactions or rusts; as vermilion, verdigrise, bice, cirrus, &c., and likewise in their vitrifications. The cause is, for that by their strength of body they are able to endure the fire or strong waters, and to be put into an equal posture; and again to retain part of their principal spirit; which two things, (equal posture and quick spirits,) are required chiefly to make colours lightsome.

Experiment solitary touching prolongation of life.

292. It conduceth unto long life, and to the more placid motion of the spirits, which thereby do less prey and consume the juice of the body, either that men's actions be free and voluntary, that nothing be done *invita Minerva*, but *secundum genium;* or on the other side, that the actions of men be full of regulation and commands within themselves: for then the victory and performing of the command giveth a good disposition to the spirits; especially if there be a proceeding from degree to degree; for then the sense of victory is the greater. An example of the former of these is in a country life; and of the latter in monks and philosophers, and such as do continually enjoin themselves.[1]

Experiment solitary touching appetite of union in bodies.

293. It is certain that in all bodies there is an appetite of union, and evitation of solution of continuity; and of this appetite there be many degrees; but the most remarkable, and fit to be distinguished, are three. The first in liquors; the second in hard bodies; and the third in bodies cleaving or tenacious. In liquors this appetite is weak: we see in liquors the threading of them in stillicides, (as hath been said); the falling of them in round drops, (which is the form of union); and the staying of them for a little time in bubbles and froth. In the second degree or kind, this appetite is strong; as in iron, in stone, in wood, &c. In the third, this appetite is in a medium

[1] The same doctrine is laid down in the *Hist. Vitæ et Mortis.*

between the other two: for such bodies do partly follow the touch of another body, and partly stick and continue to themselves; and therefore they rope, and draw themselves in threads; as we see in pitch, glue, birdlime, &c. But note, that all solid bodies are cleaving, more or less; and that they love better the touch of somewhat that is tangible, than of air. For water, in small quantity, cleaveth to any thing that is solid; and so would metal too, if the weight drew it not off. And therefore gold foliate, or any metal foliate, cleaveth: but those bodies which are noted to be clammy and cleaving, are such as have a more indifferent appetite (at once) to follow another body, and to hold to themselves. And therefore they are commonly bodies ill mixed; and which take more pleasure in a foreign body, than in preserving their own consistence; and which have little predominance in drought or moisture.

Experiment solitary touching the like operations of heat and time.[1]

294. Time and heat are fellows in many effects. Heat drieth bodies that do easily expire; as parchment, leaves, roots, clay, &c. And so doth time or age arefy; as in the same bodies, &c. Heat dissolveth and melteth bodies that keep in their spirits; as in divers liquefactions: and so doth time in some bodies of a softer consistence; as is manifest in honey, which by age waxeth more liquid; and the like in sugar; and so in old oil, which is ever more clear, and more hot in medicinable use. Heat causeth the spirits to search some issue out of the body; as in the volatility of metals: and so doth time; as in the rust of metals. But generally heat doth that in small time which age doth in long.

Experiment solitary touching the differing operations of fire and time.

295. Some things which pass the fire are softest at first, and by time grow hard; as the crumb of bread. Some are harder when they come from the fire, and afterwards give again, and grow soft; as the crust of bread, bisket, sweet-meats, salt, &c. The cause is, for that in those things which wax hard with time, the work of the fire is a kind of melting; and in those

[1] The analogy between the operations of heat and those of time are mentioned in the investigation of the form of heat in the *Novum Organum*. See the twentieth aphorism of the second book [Vol. I. p. 265.].

that wax soft with time (contrariwise) the work of the fire is a kind of baking; and whatsoever the fire baketh, time doth in some degree dissolve.

Experiment solitary touching motions by imitation.[1]

296. Motions pass from one man to another, not so much by exciting imagination, as by imitation[2]; especially if there be an aptness or inclination before. Therefore gaping, or yawning, and stretching do pass from man to man; for that that causeth gaping and stretching is, when the spirits are a little heavy, by any vapour, or the like. For then they strive (as it were) to wring out and expel that which loadeth them. So men drowsy and desirous to sleep, or before the fit of an ague, do use to yawn and stretch; and do likewise yield a voice or sound, which is an interjection of expulsion: so that if another be apt and prepared to do the like, he followeth by the sight of another. So the laughing of another maketh to laugh.

Experiment solitary touching infectious diseases.

297. There be some known diseases that are infectious; and others that are not. Those that are infectious are: First, such as are chiefly in the spirits, and not so much in the humours, and therefore pass easily from body to body; such are pestilences, lippitudes, and such like. Secondly, such as taint the breath; which we see passeth manifestly from man to man; and not invisibly, as the affects of the spirits do; such are consumptions of the lungs, &c. Thirdly, such as come forth to the skin, and therefore taint the air or the body adjacent; especially if they consist in an unctuous substance, not apt to dissipate; such are scabs and leprosy. Fourthly, such as are merely in the humours, and not in the spirits, breath, or exhalations; and therefore they never infect but by touch only; and such a touch also as cometh within the *epidermis*; as the venom of the French pox, and the biting of a mad dog.

Experiment solitary touching the incorporation of powders and liquors.

298. Most powders grow more close and coherent by mixture of water, than by mixture of oil, though oil be the thicker body; as meal, &c. The reason is the congruity of bodies; which if

[1] This and the next paragraph seem to have been suggested by Arist. *Prob.* vii.
[2] *Invitation* in the original. — *J. S.*

it be more, maketh a perfecter imbibition and incorporation; which in most powders is more between them and water, than between them and oil: but painters' colours ground, and ashes, do better incorporate with oil.

Experiment solitary touching exercise of the body.

299. Much motion and exercise is good for some bodies; and sitting and less motion for others. If the body be hot and void of superfluous moistures, too much motion hurteth; and it is an error in physicians to call too much upon exercise. Likewise men ought to beware that they use not exercise and a spare diet both: but if much exercise, then a plentiful diet; and if sparing diet, then little exercise. The benefits that come of exercise are: First, that it sendeth nourishment into the parts more forcibly. Secondly, that it helpeth to excern by sweat, and so maketh the parts assimilate the more perfectly. Thirdly, that it maketh the substance of the body more solid and compact, and so less apt to be consumed and depredated by the spirits. The evils that come of exercise are: First, that it maketh the spirits more hot and predatory. Secondly, that it doth absorb likewise, and attenuate too much the moisture of the body. Thirdly, that it maketh too great concussion (especially if it be violent) of the inward parts, which delight more in rest. But generally exercise, if it be much, is no friend to prolongation of life; which is one cause why women live longer than men, because they stir less.[1]

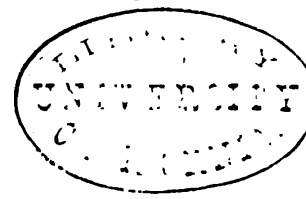
Experiment solitary touching meats that induce satiety.

300. Some food we may use long, and much, without glutting; as bread, flesh that is not fat or rank, &c. Some other (though pleasant) glutteth sooner; as sweet meats, fat meats, &c. The cause is, for that appetite consisteth in the emptiness of the mouth of the stomach; or possessing it with somewhat that is astringent, and therefore cold and dry. But things that are sweet and fat are more filling, and do swim and hang more about the mouth of the stomach, and go not down so speedily: and again turn sooner to choler, which is hot, and ever abateth the appetite. We see also that another cause of satiety is an over-custom, and of appetite is novelty; and therefore meats, if the same be continually taken, induce loathing. To give the

[1] For the same reason, according to Cardan, trees live longer than animals.

reason of the distaste of satiety, and of the pleasure in novelty; and to distinguish not only in meats and drinks, but also in motions, loves, company, delights, studies, what they be that custom maketh more grateful, and what more tedious; were a large field. But for meats, the cause is attraction, which is quicker and more excited towards that which is new, than towards that whereof there remaineth a relish by former use. And (generally) it is a rule, that whatsoever is somewhat ingrate at first, is made grateful by custom; but whatsoever is too pleasing at first, groweth quickly to satiate.[1]

[1] The subject of this paragraph is discussed by Aristotle, *Prob.* xxi. 13. and 14. He points out the distinction between active and passive habits which has been more fully developed by later writers, and especially by Butler.



NATURAL HISTORY.

CENTURY IV.

Experiments in consort touching the clarification of liquors, and the accelerating thereof.

ACCELERATION of time, in works of nature, may well be esteemed *inter magnalia naturæ.* And even in divine miracles, accelerating of the time is next to the creating of the matter. We will now therefore proceed to the inquiry of it: and for acceleration of germination, we will refer it over unto the place where we shall handle the subject of plants generally; and will now begin with other accelerations.

301. Liquors are (many of them) at the first thick and troubled; as must, wort, juice of fruits, or herbs expressed, &c.; and by time they settle and clarify. But to make them clear before the time is a great work, for it is a spur to nature, and putteth her out of her pace: and besides, it is of good use for making drinks and sauces potable and serviceable speedily. But to know the means of accelerating clarification, we must first know the causes of clarification. The first cause is, by the separation of the grosser parts of the liquor from the finer. The second, by the equal distribution of the spirits of the liquor with the tangible parts: for that ever representeth bodies clear and untroubled. The third, by the refining the spirit itself, which thereby giveth to the liquor more splendour and more lustre.

302. First, for separation; it is wrought by weight; as in the ordinary residence or settlement of liquors; by heat; by

motion; by precipitation, or sublimation (that is, a calling of the several parts either up or down, which is a kind of attraction); by adhesion, as when a body more viscous is mingled and agitated with the liquor, which viscous body (afterwards severed) draweth with it the grosser parts of the liquor; and lastly, by percolation or passage.

303. Secondly, for the even distribution of the spirits; it is wrought by gentle heat; and by agitation or motion (for of time we speak not, because it is that we would anticipate and represent); and it is wrought also by mixture of some other body, which hath a virtue to open the liquor, and to make the spirits the better pass through.

304. Thirdly, for the refining of the spirit; it is wrought likewise by heat; by motion; and by mixing of some body which hath virtue to attenuate. So therefore (having shewn the causes) for the accelerating of clarification in general, and the inducing of it, take these instances and trials.

305. It is in common practice to draw wine or beer from the lees (which we call racking); whereby it will clarify much sooner; for the lees, though they keep the drink in heart, and make it lasting, yet withal they cast up some spissitude: and this instance is to be referred to separation.

306. On the other side it were good to try what the adding to the liquor more lees than his own will work; for though the lees do make the liquor turbid, yet they refine the spirits. Take therefore a vessel of new beer, and take another vessel of new beer, and rack the one vessel from the lees, and pour the lees of the racked vessel into the unracked vessel, and see the effect: this instance is referred to the refining of the spirits.

307. Take new beer, and put in some quantity of stale beer into it, and see whether it will not accelerate the clarification, by opening the body of the beer, and cutting the grosser parts, whereby they may fall down into lees. And this instance again is referred to separation.

308. The longer malt or herbs, or the like, are infused in liquor, the more thick and troubled the liquor is; but the longer they be decocted in the liquor, the clearer it is. The reason is plain, because in infusion, the longer it is, the greater is the part of the gross body that goeth into the liquor: but in decoction, though more goeth forth, yet it either purgeth at

the top, or settleth at the bottom. And therefore the most exact way to clarify is, first to infuse, and then to take off the liquor and decoct it; as they do in beer, which hath malt first infused in the liquor, and is afterwards boiled with the hop. This also is referred to separation.

309. Take hot embers, and put them about a bottle filled with new beer, almost to the very neck: let the bottle be well stopped, lest it fly out: and continue it, renewing the embers every day, by the space of ten days: and then compare it with another bottle of the same beer set by. Take also lime both quenched and unquenched, and set the bottles in them *ut supra*. This instance is referred both to the even distribution, and also to the refining of the spirits by heat.

310. Take bottles, and swing them, or carry them in a wheel-barrow upon rough ground, twice in a day; but then you may not fill the bottles full, but leave some air; for if the liquor come close to the stopple, it cannot play nor flower: and when you have shaken them well either way, pour the drink into another bottle, stopped close after the usual manner; for if it stay with much air in it, the drink will pall; neither will it settle so perfectly in all the parts. Let it stand some twenty-four hours, then take it, and put it again into a bottle with air, *ut supra:* and thence into a bottle stopped, *ut supra:* and so repeat the same operation for seven days. Note that in the emptying of one bottle into another, you must do it swiftly, lest the drink pall. It were good also to try it in a bottle with a little air below the neck, without emptying. This instance is referred to the even distribution and refining of the spirits by motion.

311. As for percolation, inward and outward, (which belongeth to separation,) trial would be made of clarifying by adhesion, with milk put into new beer, and stirred with it: for it may be that the grosser part of the beer will cleave to the milk: the doubt is, whether the milk will sever well again: which is soon tried. And it is usual in clarifying hippocras to put in milk; which after severeth and carrieth with it the grosser parts of the hippocras, as hath been said elsewhere. Also for the better clarification by percolation, when they tun new beer, they use to let it pass through a strainer; and it is like the finer the strainer is, the clearer it will be.

Experiments in consort touching maturation, and the accelerating thereof. And first, touching the maturation and quickening of drinks. And next, touching the maturation of fruits.

The accelerating of maturation we will now inquire of, and of maturation itself. It is of three natures. The maturation of fruits, the maturation of drinks, and the maturation of impostumes and ulcers. This last we refer to another place, where we shall handle experiments medicinal. There be also other maturations, as of metals, &c., whereof we will speak as occasion serveth. But we will begin with that of drinks, because it hath such affinity with the clarification of liquors.

312. For the maturation of drinks, it is wrought by the congregation of the spirits together, whereby they digest more perfectly the grosser parts: and it is effected partly by the same means that clarification is (whereof we spake before); but then note, that an extreme clarification doth spread the spirits so smooth, as they become dull, and the drink dead, which ought to have a little flowering. And therefore all your clear amber drink is flat.

313. We see the degrees of maturation of drinks, in must; in wine, as it is drunk; and in vinegar. Whereof must hath not the spirits well congregated; wine hath them well united, so as they make the parts somewhat more oily; vinegar hath them congregated, but more jejune, and in smaller quantity, the greatest and finest spirit and part being exhaled: for we see vinegar is made by setting the vessel of wine against the hot sun; and therefore vinegar will not burn; for that much of the finer part is exhaled.

314. The refreshing and quickening of drink palled or dead, is by enforcing the motion of the spirit: so we see that open weather relaxeth the spirit, and maketh it more lively in motion. We see also bottling of beer or ale, while it is new and full of spirit, (so that it spirteth when the stopple is taken forth,) maketh the drink more quick and windy. A pan of coals in the cellar doth likewise good, and maketh the drink work again. New drink put to drink that is dead provoketh it to work again: nay, which is more, (as some affirm) a brewing of new beer, set by old beer, maketh it work again. It were

good also to enforce the spirits by some mixtures that may excite and quicken them; as by the putting into the bottles, nitre, chalk, lime, &c. We see cream is matured, and made to rise more speedily, by putting in cold water; which, as it seemeth, getteth down the whey.

315. It is tried, that the burying of bottles of drink well stopped, either in dry earth a good depth, or in the bottom of a well within water, and best of all, the hanging of them in a deep well somewhat above the water, for some fortnight's space, is an excellent means of making drink fresh and quick; for the cold doth not cause any exhaling of the spirits at all; as heat doth, through it rarifieth the rest that remain; but cold maketh the spirits vigorous, and irritateth them, whereby they incorporate the parts of the liquor perfectly.

316. As for the maturation of fruits, it is wrought by the calling forth of the spirits of the body outward, and so spreading them more smoothly: and likewise by digesting in some degree the grosser parts; and this is effected by heat; motion; attraction; and by a rudiment of putrefaction; for the inception of putrefaction hath in it a maturation.

317. There were taken apples, and laid in straw; in hay; in flour; in chalk; in lime; covered over with onions; covered over with crabs; closed up in wax; shut in a box, &c. There was also an apple hanged up in smoke. Of all which the experiments sorted in this manner.

318. After a month's space, the apple inclosed in wax was as green and fresh as at the first putting in, and the kernels continued white. The cause is, for that all exclusion of open air (which is ever predatory) maintaineth the body in his first freshness and moisture; but the inconvenience is, that it tasteth a little of the wax; which, I suppose, in a pomegranate or some such thick-coated fruit, it would not do.

319. The apple hanged in the smoke turned like an old mellow apple, wrinkled, dry, soft, sweet, yellow within. The cause is, for that such a degree of heat which doth neither melt nor scorch (for we see that in a great heat, a roast apple softeneth and melteth; and pigs' feet, made of quarters of wardens, scorch and have a skin of coal,) doth mellow, and not adure: the smoke also maketh the apple (as it were) sprinkled with soot, which helpeth to mature. We see that in drying of pears and prunes in the oven, and removing of them often as

they begin to sweat, there is a like operation; but that is with a far more intense degree of heat.

320. The apples covered in the lime and ashes were well matured; as appeared both in their yellowness and sweetness. The cause is, for that that degree of heat which is in lime and ashes (being a smothering heat) is of all the rest most proper; for it doth neither liquefy nor arefy; and that is true maturation. Note, that the taste of those apples was good; and therefore it is the experiment fittest for use.

321. The apples covered with crabs and onions were likewise well matured. The cause is, not any heat; but for that the crabs and the onions draw forth the spirits of the apple, and spread them equally throughout the body; which taketh away hardness. So we see one apple ripeneth against another. And therefore in making of cyder they turn the apples first upon a heap. So one cluster of grapes that toucheth another whilst it groweth, ripeneth faster; *botrus contra botrum citius maturescit.*[1]

322. The apples in hay and the straw ripened apparently, though not so much as the other; but the apple in the straw more. The cause is, for that the hay and straw have a very low degree of heat, but yet close and smothering, and which drieth not.

323. The apple in the close box was ripened also: the cause is, for that all air kept close hath a degree of warmth; as we see in wool, fur, plush, &c.

Note, that all of these were compared with another apple of the same kind that lay of itself; and in comparison of that were more sweet and more yellow, and so appeared to be more ripe.

324. Take an apple or pear, or other like fruit, and roll it upon a table hard: we see in common experience, that the rolling doth soften and sweeten the fruit presently; which is nothing but the smooth distribution of the spirits into the parts; for the unequal distribution of the spirits maketh the harshness[2]: but this hard rolling is between concoction and a simple maturation; therefore, if you should roll them but gently, perhaps twice a day, and continue it some seven days, it is like they would mature more finely, and like unto the natural maturation.

[1] This is taken from Erasmus's *Adages*, iii. 2. 49.
[2] *Harrishness* in the original.—*J. S.*

325. Take an apple, and cut out a piece of the top, and cover it, to see whether that solution of continuity will not hasten a maturation: we see that where a wasp or a fly or a worm hath bitten in a grape or any fruit, it will sweeten hastily.

326. Take an apple, &c., and prick it with a pin full of holes, not deep, and smear it a little with sack, or cinnamon water, or spirit of wine, every day for ten days, to see if the virtual heat of the wine or strong waters will not mature it.

In these trials also, as was used in the first, set another of the same fruits by, to compare them; and try them by their yellowness and by their sweetness.

Experiment solitary touching the making of gold.

The world hath been much abused by the opinion of making of gold: the work itself I judge to be possible; but the means (hitherto propounded) to effect it are, in the practice, full of error and imposture; and in the theory, full of unsound imaginations. For to say that nature hath an intention to make all metals gold; and that if she were delivered from impediments, she would perform her own work; and that if the crudities, impurities, and leprosies of metals were cured, they would become gold; and that a little quantity of the medicine, in the work of projection, will turn a sea of the baser metal into gold by multiplying: all these are but dreams; and so are many other grounds of alchemy. And to help the matter, the alchemists call in likewise many vanities out of astrology, natural magic, superstitious interpretations of Scriptures, auricular traditions, feigned testimonies of ancient authors, and the like. It is true, on the other side, they have brought to light not a few profitable experiments, and thereby made the world some amends. But we, when we shall come to handle the version and transmutation of bodies, and the experiments concerning metals and minerals, will lay open the true ways and passages of nature, which may lead to this great effect. And we commend the wit of the Chineses, who despair of making of gold, but are mad upon the making of silver[1]: for cer-

[1] See Purchas's *Pilgrims*, iii. 332., and v. 467. But these passages do not show that the Chinese despaired of being able to make gold, and it is therefore probable that Bacon's information was derived from some other source.

tain it is that it is more difficult to make gold (which is the most ponderous and materiate amongst metals) of other metals less ponderous and less materiate, than (*via versa*) to make silver of lead or quicksilver; both which are more ponderous than silver; so that they need rather a further degree of fixation than any condensation. In the mean time, by occasion of handling the axioms touching maturation, we will direct a trial touching the maturing of metals, and thereby turning some of them into gold: for we conceive indeed that a perfect good concoction or digestion or maturation of some metals will produce gold. And here we call to mind that we knew a Dutchman, that had wrought himself into the belief of a great person by undertaking that he could make gold, whose discourse was, that gold might be made; but that the alchemists over-fired the work: for (he said) the making of gold did require a very temperate heat, as being in nature a subterrany work, where little heat cometh; but yet more to the making of gold than of any other metal; and therefore that he would do it with a great lamp that should carry a temperate and equal heat; and that it was the work of many months. The device of the lamp was folly; but the over-firing now used, and the equal heat to be required, and the making it a work of some good time, are no ill discourses.

We resort therefore to our axioms of maturation, in effect touched before. The first is, that there be used a temperate heat; for they are ever temperate heats that digest and mature: wherein we mean temperate according to the nature of the subject; for that may be temperate to fruits and liquors, which will not work at all upon metals. The second is, that the spirit of the metal be quickened, and the tangible parts opened: for without those two operations, the spirit of the metal wrought upon will not be able to digest the parts. The third is, that the spirits do spread themselves even, and move not subsultorily; for that will make the parts close and pliant. And this requireth a heat that doth not rise and fall, but continue as equal as may be. The fourth is, that no part of the spirit be emitted, but detained: for if there be emission of spirit, the body of

the metal will be hard and churlish. And this will be performed, partly by the temper of the fire, and partly by the closeness of the vessel. The fifth is, that there be choice made of the likeliest and best prepared metal for the version: for that will facilitate the work. The sixth is, that you give time enough for the work; not to prolong hopes (as the alchemists do), but indeed to give nature a convenient space to work in. These principles are most certain and true; we will now derive a direction of trial out of them, which may perhaps by further meditation be improved.

327. Let there be a small furnace made, of a temperate heat; let the heat be such as may keep the metal perpetually molten, and no more; for that above all importeth to the work. For the material, take silver, which is the metal that in nature symbolizeth most with gold[1]; put in also with the silver, a tenth part of quicksilver, and a twelfth part of nitre, by weight; both these to quicken and open the body of the metal; and so let the work be continued by the space of six months at the least. I wish also, that there be at some times an injection of some oiled substance; such as they use in the recovering of gold, which by vexing with separations hath been made churlish; and this is to lay the parts more close and smooth, which is the main work. For gold (as we see) is the closest (and therefore the heaviest) of metals; and is likewise the most flexible and tensible. Note, that to think to make gold of quicksilver, because it is the heaviest, is a thing not to be hoped; for quicksilver will not endure the manage of the fire. Next to silver, I think copper were fittest to be the material.

Experiment solitary touching the nature of gold.

328. Gold hath these natures; greatness of weight, closeness of parts, fixation, pliantness or softness, immunity from rust, colour or tincture of yellow. Therefore the sure way (though most about) to make gold, is to know the causes of the several natures before rehearsed, and the axioms concerning the same. For if a man can make a metal that hath all these properties, let men dispute whether it be gold or no.

[1] Beside the symbolisms between gold and silver with which Bacon was acquainted, two very remarkable relations have been since observed — their isomorphism, and the equality of their equivalent volumes. In both these respects they agree with Tellurium, and the three metals are frequently found combined or associated together.

Experiments in consort touching the inducing and accelerating of putrefaction.

The inducing and accelerating of putrefaction is a subject of a very universal inquiry: for corruption is a reciprocal to generation: and they two are as nature's two terms or boundaries; and the guides to life and death. Putrefaction is the work of the spirits of bodies, which ever are unquiet to get forth and congregate with the air, and to enjoy the sunbeams. The getting forth, or spreading of the spirits (which is a degree of getting forth), have five differing operations. If the spirits be detained within the body, and move more violently, there followeth colliquation; as in metals, &c. If more mildly, there followeth digestion or maturation; as in drinks and fruits. If the spirits be not merely detained, but protrude a little, and that motion be confused and inordinate, there followeth putrefaction; which ever dissolveth the consistence of the body into much inequality; as in flesh, rotten fruits, shining wood, &c., and also in the rust of metals. But if that motion be in a certain order, there followeth vivification and figuration; as both in living creatures bred of putrefaction, and in living creatures perfect. But if the spirits issue out of the body, there followeth desiccation, induration, consumption, &c.; as in brick, evaporation of bodies liquid, &c.

329. The means to induce and accelerate putrefaction are, first, by adding some crude or watery moisture; as in wetting of any flesh, fruit, wood, with water, &c. For contrariwise unctuous and oily substances preserve.

330. The second is by invitation or excitation; as when a rotten apple lieth close to another apple that is sound; or when dung (which is a substance already putrefied) is added to other bodies. And this is also notably seen in church-yards, where they bury much; where the earth will consume the corpse in far shorter time than other earth will.

331. The third is by closeness and stopping, which detaineth the spirits in prison more than they would; and thereby irritateth them to seek issue; as in corn and clothes, which wax musty; and therefore open air, (which they call *aër perflabilis*,) doth preserve: and this doth appear more evidently in agues,

which come (most of them) of obstructions, and penning the humours, which thereupon putrefy.

332. The fourth is by solution of continuity: as we see an apple will rot sooner if it be cut or pierced; and so will wood, &c. And so the flesh of creatures alive, where they have received any wound.

333. The fifth is either by the exhaling or by the driving back of the principal spirits, which preserve the consistence of the body; so that when their government is dissolved, every part returneth to his nature or homogeny. And this appeareth in urine and blood, when they cool, and thereby break: it appeareth also in the gangrene, or mortification of flesh, either by opiates or by intense colds. I conceive also the same effect is in pestilences; for that the malignity of the infecting vapour daunteth[1] the principal spirits, and maketh them fly and leave their regiment; and then the humours, flesh, and secondary spirits, do dissolve and break, as in an anarchy.

334. The sixth is, when a foreign spirit, stronger and more eager than the spirit of the body, entereth the body; as in the stinging of serpents. And this is the cause (generally) that upon all poisons followeth swelling: and we see swelling followeth also when the spirits of the body itself congregate too much; as upon blows and bruises; or when they are pent in too much, as in swelling upon cold. And we see also, that the spirits coming of putrefaction of humours in agues, &c., which may be counted as foreign spirits though they be bred within the body, do extinguish and suffocate the natural spirits and heat.

335. The seventh is by such a weak degree of heat, as setteth the spirits in a little motion, but is not able either to digest the parts, or to issue the spirits; as is seen in flesh kept in a room that is not cool; whereas in a cool and wet larder it will keep longer. And we see that vivification (whereof putrefaction is the bastard brother) is effected by such soft heats; as the hatching of eggs, the heat of the womb, &c.

336. The eighth is by the releasing of the spirits, which before were close kept by the solidness of their coverture, and thereby their appetite of issuing checked; as in the artificial rusts induced by strong waters in iron, lead, &c. And there-

[1] *Daunceth* in the original. — *J. S.*

fore wetting hasteneth rust or putrefaction of any thing, because it softeneth the crust for the spirits to come forth.

337. The ninth is by the interchange of heat and cold, or wet and dry; as we see in the mouldering of earth in frosts and sun: and in the more hasty rotting of wood that is sometimes wet, sometimes dry.

338. The tenth is by time, and the work and procedure of the spirits themselves, which cannot keep their station; especially if they be left to themselves, and there be not agitation or local motion. As we see in corn not stirred, and men's bodies not exercised.

339. All moulds are inceptions of putrefaction; as the moulds of pies and flesh; the moulds of oranges and lemons; which moulds afterwards turn into worms, or more odious putrefactions; and therefore (commonly) prove to be of ill odour. And if the body be liquid, and not apt to putrefy totally, it will cast up a mother in the top; as the mothers of distilled waters.

340. Moss is a kind of mould of the earth and trees. But it may be better sorted as a rudiment of germination, to which we refer it.

Experiments in consort touching prohibiting and preventing putrefaction.

It is an inquiry of excellent use to inquire of the means of preventing or staying putrefaction; for therein consisteth the means of conservation of bodies: for bodies have two kinds of dissolutions; the one by consumption and desiccation, the other by putrefaction. But as for the putrefactions of the bodies of men and living creatures (as in agues, worms, consumptions of the lungs, impostumes, and ulcers both inwards and outwards) they are a great part of physic and surgery; and therefore we will reserve the inquiry of them to the proper place, where we shall handle medicinal experiments of all sorts. Of the rest we will now enter into an inquiry: wherein much light may be taken from that which hath been said of the means to induce or accelerate putrefaction: for the removing that which caused putrefaction, doth prevent and avoid putrefaction.

341. The first means of prohibiting or checking putrefaction is cold: for so we see that meat and drink will last longer unputrefied, or unsoured, in winter than in summer: and we see that flowers and fruits, put in conservatories of snow, keep fresh. And this worketh by the detention of the spirits, and constipation of the tangible parts.

342. The second is astriction: for astriction prohibiteth dissolution; as we see (generally) in medicines, whereof such as are astringents do inhibit putrefaction: and by the same reason of astringency, some small quantity of oil of vitriol will keep fresh water long from putrefying. And this astriction is in a substance that hath a virtual cold; and it worketh (partly) by the same means that cold doth.

343. The third is the excluding of the air; and again, the exposing to the air: for these contraries (as it cometh often to pass) work the same effect, according to the nature of the subject matter. So we see that beer or wine, in bottles close stopped, last long; that the garners under ground keep corn longer than those above ground; and that fruit closed in wax keepeth fresh; and likewise bodies put in honey and flour keep more fresh: and liquors, drinks, and juices, with a little oil cast on the top, keep fresh. Contrariwise, we see that cloth and apparel not aired do breed moths and mould; and the diversity is, that in bodies that need detention of spirits, the exclusion of the air doth good; as in drinks and corn: but in bodies that need emission of spirits to discharge some of the superfluous moisture, it doth hurt, for they require airing.

344. The fourth is motion and stirring; for putrefaction asketh rest: for the subtile motion which putrefaction requireth, is disturbed by any agitation: and all local motion keepeth bodies integral, and their parts together; as we see that turning over of corn in a garner, or letting it run like an hour-glass from an upper room into a lower, doth keep it sweet: and running waters putrefy not; and in men's bodies, exercise hindereth putrefaction; and contrariwise, rest and want of motion, or stoppings, (whereby the run of humours, or the motion of perspiration is stayed,) further putrefaction; as we partly touched a little before.

345. The fifth is the breathing forth of the adventitious moisture in bodies; for as wetting doth hasten putrefaction, so convenient drying (whereby the more radical moisture is only

kept in) putteth back putrefaction; so we see that herbs and flowers, if they be dried in the shade, or dried in the hot sun for a small time, keep best. For the emission of the loose and adventitious moisture doth betray the radical moisture, and carrieth it out for company.

346. The sixth is the strengthening of the spirits of bodies; for as a great heat keepeth bodies from putrefaction, but a tepid heat inclineth them to putrefaction; so a strong spirit likewise preserveth, and a weak or faint spirit disposeth to corruption. So we find that salt water corrupteth not so soon as fresh: and salting of oysters, and powdering of meat, keepeth them from putrefaction. It would be tried also whether chalk put into water or drink doth not preserve it from putrefying or speedy souring. So we see that strong beer will last longer than small; and all things that are hot and aromatical do help to preserve liquors, or powders, &c.; which they do as well by strengthening the spirits, as by soaking[1] out the loose moisture.

347. The seventh is separation of the cruder parts, and thereby making the body more equal; for all unperfect mixture is apt to putrefy; and watery substances are more apt to putrefy than oily. So we see distilled waters will last longer than raw waters; and things that have passed the fire do last longer than those that have not passed the fire; as dried pears, &c.

348. The eighth is the drawing forth continually of that part where the putrefaction beginneth; which is (commonly) the loose and watery moisture; not only for the reason before given, that it provoketh the radical moisture to come forth with it; but because being detained in the body, the putrefaction taking hold of it, infecteth the rest: as we see in the embalming dead bodies; and the same reason is of preserving herbs, or fruits, or flowers, in bran or meal.

349. The ninth is the commixture of any thing that is more oily or sweet: for such bodies are least apt to putrefy, the air working little upon them; and they not putrefying, preserve the rest. And therefore we see syrups and ointments will last longer than juices.

350. The tenth is the commixture of somewhat that is dry; for putrefaction beginneth first from the spirits, and then from the moisture: and that that is dry is unapt to putrefy: and

[1] So in the original. — *J. S.*

therefore smoke preserveth flesh; as we see in bacon, and neats' tongues, and Martlemas beef[1], &c.

351. The opinion of some of the ancients, that blown airs do preserve bodies longer than other airs, seemeth to me probable[2]; for that the blown airs, being overcharged and compressed, will hardly receive the exhaling of any thing, but rather repulse it. It was tried in a blown bladder, whereinto flesh was put, and likewise a flower, and it sorted not: for dry bladders will not blow; and new bladders rather further putrefaction: the way were therefore to blow strongly with a pair of bellows into a hogshead, putting into the hogshead (before) that which you would have preserved; and in the instant that you withdraw the bellows, stop the hole close.

Experiment solitary touching wood shining in the dark.

352. The experiment of wood that shineth in the dark, we have diligently driven and pursued: the rather, for that of all things that give light here below, it is the most durable, and hath least apparent motion. Fire and flame are in continual expence; sugar shineth only while it is in scraping; and salt-water while it is in dashing; glow-worms have their shining while they live, or a little after. Only scales of fishes (putrefied) seem to be of the same nature with shining wood: and it is true that all putrefaction hath with it an inward motion, as well as fire or light. The trial sorted thus: 1. The shining is in some pieces more bright, in some more dim; but the most bright of all doth not attain to the light of a glow-worm. 2. The woods that have been tried to shine, are chiefly sallow and willow: also the ash and hazle; it may be it holdeth in others. 3. Both roots and bodies do shine, but the roots better. 4. The colour of the shining part, by day-light, is in some pieces white, in some pieces inclining to red; which in the country they call the white and red garret. 5. The part that shineth is (for the most part) somewhat soft and moist to feel to; but some was found to be firm and hard; so as it might be figured into a cross, or into beads, &c. But you must not look to have an image, or the like, in any thing that is lightsome; for even a face in iron red-hot will not be seen, the light confounding the small differences of lightsome and dark-

[1] For an account of the phrase Martlemas-beef, see Macaulay, *History of England*, vol. i. p. 315.

[2] Arist. Prob. xxii. 4. and xxv. 17.

some, which shew the figure. 6. There was the shining part pared off, till you came to that that did not shine; but within two days the part contiguous began also to shine, being laid abroad in the dew; so as it seemeth the putrefaction spreadeth. 7. There was other dead wood of like kind that was laid abroad, which shined not at the first; but after a night's lying abroad began to shine. 8. There was other wood that did first shine; and being laid dry in the house, within five or six days lost the shining; and laid abroad again, recovered the shining. 9. Shining woods being laid in a dry room, within a sevennight lost their shining; but being laid in a cellar, or dank room, kept the shining. 10. The boring of holes in that kind of wood, and then laying it abroad, seemeth to conduce to make it shine: the cause is, for that all solution of continuity doth help on putrefaction, as was touched before. 11. No wood hath been yet tried to shine, that was cut down alive, but such as was rotted both in stock and root while it grew. 12. Part of the wood that shined was steeped in oil, and retained the shining a fortnight. 13. The like succeeded in some steeped in water, and much better. 14. How long the shining will continue, if the wood be laid abroad every night, and taken in and sprinkled with water in the day, is not yet tried. 15. Trial was made of laying it abroad in frosty weather, which hurt it not. 16. There was a great piece of a root which did shine, and the shining part was cut off till no more shined; yet after two nights, though it were kept in a dry room, it got a shining.

Experiment solitary touching the acceleration of birth.

353. The bringing forth of living creatures may be accelerated in two respects: the one, if the embryo ripeneth and perfecteth sooner: the other, if there be some cause from the mother's body, of expulsion or putting it down: whereof the former is good, and argueth strength; the latter is ill, and cometh by accident or disease. And therefore the ancient observation is true, that the child born in the seventh month doth commonly well; but born in the eighth month doth (for the most part) die. But the cause assigned is fabulous; which is, that in the eighth month should be the return of the reign of the planet Saturn, which (as they say) is a planet malign; whereas in the seventh is the reign of the moon, which is a

planet propitious.[1] But the true cause is, for that where there is so great a prevention of the ordinary time, it is the lustiness of the child; but when it is less, it is some indisposition of the mother.

Experiment solitary touching the acceleration of growth and stature.

354. To accelerate growth or stature, it must proceed either from the plenty of the nourishment, or from the nature of the nourishment, or from the quickening and exciting of the natural heat. For the first, excess of nourishment is hurtful; for it maketh the child corpulent; and growing in breadth rather than in height. And you may take an experiment from plants, which if they spread much are seldom tall. As for the nature of the nourishment: First, it may not be too dry; and therefore children in dairy countries do wax more tall, than where they feed more upon bread and flesh. There is also a received tale, that boiling of daisy roots in milk (which it is certain are great driers) will make dogs little. But so much is true, that an over-dry nourishment in childhood putteth back stature. Secondly, the nourishment must be of an opening nature; for that attenuateth the juice, and furthereth the motion of the spirits upwards. Neither is it without cause, that Xenophon, in the nurture of the Persian children, doth so much commend their feeding upon cardamon; which (he saith) made them grow better, and be of a more active habit.[2] Cardamon is in Latin *nasturtium*, and with us *water-cresses*; which, it is certain, is an herb that, whilst it is young, is friendly to life. As for the quickening of natural heat, it must be done chiefly with exercise; and therefore (no doubt) much going to school, where they sit so much, hindereth the growth of children; whereas country people that go not to school, are commonly of better stature. And again men must beware how they give children

[1] We read in Omar that the first month after conception "fit in dispositione Saturni disponitque eum per frigus." The second is similarly influenced by Jupiter, and so on. Thus the seventh is influenced by the Moon — "fit in dispositione Lunæ et perficitur in eo ejus imago. Qui si tunc in dispositione Lunæ fuerit natus evadet. Si vero fuerit natus in octavo revertitur in eo dispositio Saturni et morietur. Et si natus fuerit in nono mense revertitur dispositio ad Jovem et vivit, si Deus voluerit." — *Omar, De Nativitatibus*, iii., appended to the Basil edition of Julius Firmicus (1551).

Censorinus, *De Die natali*, c. 8., gives quite a different reason. The phrase "perficitur in eo ejus imago" means that in the seventh month the face of the child is perfected, and that it is an image or ectype of that which is seen in the moon.

[2] Xenophon, Cyropæd. i. 2.

any thing that is cold in operation; for even long sucking doth hinder both wit and stature. This hath been tried, that a whelp that hath been fed with nitre in milk, hath become very little, but extreme lively: for the spirit of nitre is cold. And though it be an excellent medicine in strength of years for prolongation of life, yet it is in children and young creatures an enemy to growth; and all for the same reason; for heat is requisite to growth; but after a man is come to his middle age, heat consumeth the spirits; which the coldness of the spirit of nitre doth help to condense and correct.

Experiments in consort touching sulphur and mercury, two of Paracelsus' Principles.

There be two great families of things. You may term them by several names; sulphureous and mercurial, which are the chemist's words (for as for their *sal*, which is their third Principle, it is a compound of the other two); inflammable and not inflammable; mature and crude; oily and watery. For we see that in subterranies there are, as the fathers of their tribes, brimstone and mercury; in vegetables and living creatures there is water and oil; in the inferior order of pneumaticals there is air and flame; and in the superior there is the body of the star and the pure sky. And these pairs, though they be unlike in the primitive differences of matter, yet they seem to have many consents: for mercury and sulphur are principal materials of metals; water and oil are principal materials of vegetables and animals, and seem to differ but in maturation or concoction: flame (in vulgar opinion) is but air incensed; and they both have quickness of motion, and facility of cession, much alike: and the interstellar sky (though the opinion be vain, that the star is the denser part of his orb) hath notwithstanding so much affinity with the star, that there is a rotation of that, as well as of the star. Therefore it is one of the greatest *magnalia naturæ*, to turn water or watery juice into oil or oily juice: greater in nature, than to turn silver or quicksilver into gold.

355. The instances we have wherein crude and watery substance turneth into fat and oily, are of four kinds. First in the mixture of earth and water; which mingled by the help of the

sun, gather a nitrous fatness, more than either of them have severally; as we see in that they put forth plants, which need both juices.

356. The second is in the assimilation of nourishment, made in the bodies of plants and living creatures; whereof plants turn the juice of mere water and earth into a great deal of oily matter: living creatures, though much of their fat and flesh are out of oily aliments (as meat and bread), yet they assimilate also in a measure their drink of water, &c. But these two ways of version of water into oil (namely, by mixture and by assimilation) are by many passages and percolations, and by continuance of soft heats, and by circuits of time.

357. The third is the inception of putrefaction; as in water corrupted; and the mothers of waters distilled; both which have a kind of fatness or oil.

358. The fourth is in the dulcoration of some metals, as *saccharum Saturni*, &c.

359. The intention of version of water into a more oily substance is by digestion; for oil is almost nothing else but water digested; and this digestion is principally by heat; which heat must be either outward or inward: again, it may be by provocation or excitation; which is caused by the mingling of bodies already oily or digested; for they will somewhat communicate their nature with the rest. Digestion also is strongly effected by direct assimilation of bodies crude into bodies digested; as in plants and living creatures, whose nourishment is far more crude than their bodies: but this digestion is by a great compass, as hath been said. As for the more full handling of these two principles, whereof this is but a taste, (the inquiry of which is one of the profoundest inquiries of nature), we leave it to the title of version of bodies; and likewise to the title of the first congregations of matter; which, like a general assembly of estates, doth give law to all bodies.

Experiment solitary touching chameleons.[1]

360. A chameleon is a creature about the bigness of an ordinary lizard: his head unproportionably big: his eyes great: he moveth his head without the writhing of his neck (which is in-

[1] This description is taken from Scaliger, *Exercit. adv. Cardan.* 196. 4. The "tradition in magic" at the end of the paragraph is given with a slight variation by Pliny, xxviii. 29. That the burning was to be on the house-top was probably suggested by the words "in tegulis" in the latter passage.

flexible) as a hog doth: his back crooked; his skin spotted with little tumours, less eminent nearer the belly; his tail slender and long: on each foot he hath five fingers, three on the outside, and two on the inside; his tongue of a marvellous length in respect of his body, and hollow at the end; which he will launch out to prey upon flies. Of colour green, and of a dusky yellow, brighter and whiter towards the belly; yet spotted with blue, white, and red. If he be laid upon green, the green predominateth; if upon yellow, the yellow; not so if he be laid upon blue, or red, or white; only the green spots receive a more orient lustre; laid upon black, he looketh all black, though not without a mixture of green. He feedeth not only upon air, (though that be his principal sustenance,) for sometimes he taketh flies, as was said; yet some that have kept chameleons a whole year together, could never perceive that ever they fed upon any thing else but air, and might observe their bellies to swell after they had exhausted the air; and closed their jaws; which they open commonly against the rays of the sun. They have a foolish tradition in magic, that if a chameleon be burnt upon the top of an house, it will raise a tempest; supposing (according to their vain dreams of sympathies,) because he nourisheth with air, his body should have great virtue to make impression upon the air.

Experiment solitary touching subterrany fires.[1]

361. It is reported by one of the ancients, that in part of Media there are eruptions of flames out of plains; and that those flames are clear, and cast not forth such smoke and ashes and pumice, as mountain flames do. The reason (no doubt) is, because the flame is not pent as it is in mountains and earthquakes which cast flame. There be also some blind fires under stone, which flame not out, but oil being poured upon them they flame out. The cause whereof is, for that it seemeth the fire is so choked, as not able to remove the stone, it is heat rather than flame; which nevertheless is sufficient to inflame the oil.

Experiment solitary touching nitre.

362. It is reported, that in some lakes[2] the water is so nitrous, as, if foul clothes be put into it, it scoureth them of itself; and if they stay any whit long, they moulder away. And the

[1] Pliny, ii. 110. [2] Namely, lake Pæsa. Arist. Probl. xxiii. 40.

scouring virtue of nitre is the more to be noted, because it is a body cold; and we see warm water scoureth better than cold. But the cause is, for that it hath a subtile spirit, which severeth and divideth any thing that is foul and viscous and sticketh upon a body.

Experiment solitary touching congealing of air.

363. Take a bladder, the greatest you can get; fill it full of wind, and tie it about the neck with a silk thread waxed; and upon that put likewise wax very close; so that when the neck of the bladder drieth, no air may possibly get in nor out. Then bury it three or four foot under the earth in a vault, or in a conservatory of snow, the snow being made hollow about the bladder; and after some fortnight's distance, see whether the bladder be shrunk; for if it be, then it is plain that the coldness of the earth or snow hath condensed the air, and brought it a degree nearer to water: which is an experiment of great consequence.

Experiment solitary touching congealing of water into crystal.

364. It is a report of some good credit, that in deep caves there are pensile crystals, and degrees of crystal that drop from above; and in some other (though more rarely) that rise from below: which though it be chiefly the work of cold, yet it may be that water that passeth through the earth gathereth a nature more clammy, and fitter to congeal and become solid, than water of itself. Therefore trial would be made, to lay a heap of earth, in great frosts, upon a hollow vessel, putting a canvas between, that it falleth not in: and pour water upon it, in such quantity as will be sure to soak through; and see whether it will not make an harder ice in the bottom of the vessel, and less apt to dissolve, than ordinarily. I suppose also that if you make the earth narrower at the bottom than at the top, in fashion of a sugar-loaf reversed, it will help the experiment. For it will make the ice, where it issueth, less in bulk; and evermore smallness of quantity is a help to version.

Experiment solitary touching preserving of rose-leaves, both in colour and smell.

365. Take damask roses, and pull them; then dry them upon the top of an house, upon a lead or terrace, in the hot sun, in a clear day, between the hours (only) of twelve and two, or thereabouts. Then put them into a sweet dry earthen bottle, or a

glass, with narrow mouths, stuffing them close together, but without bruising: stop the bottle or glass close, and these roses will retain not only their smell perfect, but their colour fresh, for a year at least. Note, that nothing doth so much destroy any plant or other body, either by putrefaction or arefaction, as the adventitious moisture which hangeth loose in the body, if it be not drawn out. For it betrayeth and tolleth forth the innate and radical moisture along with it, when itself goeth forth. And therefore in living creatures, moderate sweat doth preserve the juice of the body. Note, that these roses, when you take them from the drying, have little or no smell; so that the smell is a second smell, that issueth out of the flower afterwards.

Experiments in consort touching the continuance of flame.

366. The continuance of flame, according unto the diversity of the body inflamed, and other circumstances, is worthy the inquiry; chiefly, for that though flame be (almost) of a momentany lasting, yet it receiveth the more and the less: we will first therefore speak (at large) of bodies inflamed wholly and immediately, without any wick[1] to help the inflammation. A spoonful of spirit of wine, a little heated, was taken, and it burnt as long as came to one hundred and sixteen pulses. The same quantity of spirit of wine mixed with the sixth part of a spoonful of nitre, burnt but to the space of ninety-four pulses. Mixed with the like quantity of bay-salt, eighty-three pulses. Mixed with the like quantity of gunpowder, which dissolved into a black water, one hundred and ten pulses. A cube or pellet of yellow wax was taken, as much as half the spirit of wine, and set in the midst, and it burnt only to the space of eighty-seven pulses. Mixed with the sixth part of a spoonful of milk, it burnt to the space of one hundred pulses; and the milk was crudled. Mixed with the sixth part of a spoonful of water, it burnt to the space of eighty-six pulses; with an equal quantity of water, only to the space of four pulses. A small pebble was laid in the midst; and the spirit of wine burnt to the space of ninety-four pulses. A piece of wood of the bigness of an arrow, and about a finger's length, was set up in the midst, and the spirit of wine burnt to the space of ninety-four pulses. So that the spirit of wine simple endured the longest; and

[1] In the original this word is always spelt *wieke*. — *J. S.*

the spirit of wine with the bay-salt, and the equal quantity of water, were the shortest.

367. Consider well, whether the more speedy going forth of the flame be caused by the greater vigour of the flame in burning; or by the resistance of the body mixed, and the aversion thereof to take flame; which will appear by the quantity of the spirit of wine that remaineth after the going out of the flame. And it seemeth clearly to be the latter; for that the mixture of things least apt to burn is the speediest in going out. And note, by the way, that spirit of wine, burned till it go out of itself, will burn no more; and tasteth nothing so hot in the mouth as it did; no, nor yet sour (as if it were a degree towards vinegar), which burnt wine doth; but flat and dead.

368. Note, that in the experiment of wax aforesaid, the wax dissolved in the burning, and yet did not incorporate itself with the spirit of the wine to produce one flame: but whersoever the wax floated, the flame forsook it, till at last it spread all over, and put the flame quite out.

369. The experiments of the mixtures of the spirit of wine inflamed, are things of discovery, and not of use: but now we will speak of the continuance of flames, such as are used for candles, lamps, or tapers; consisting of inflammable matters, and of a wick that provoketh inflammation. And this importeth not only discovery, but also use and profit; for it is a great saving in all such lights, if they can be made as fair and bright as others, and yet last longer. Wax pure made into a candle; and wax mixed severally into candle-stuff with the particulars that follow, (viz., water, aqua-vitæ, milk, bay-salt, oil, butter, nitre, brimstone, saw-dust); every of these bearing a sixth part to the wax; and every of these candles mixed, being of the same weight and wick with the wax pure; proved thus in the burning and lasting. The swiftest in consuming was that with saw-dust; which first burned fair till some part of the candle was consumed, and the dust gathered about the snaste [1]; but then it made the snaste big and long, and to burn duskishly, and the candle wasted in half the time of the wax pure. The next in swiftness were the oil and butter, which consumed by a fifth part swifter than the pure wax. Then followed in swiftness the clear wax itself. Then the bay-salt,

[1] *Snaste* is apparently the same word as snat, which is given in Bailey's Dictionary as a North-country word for burnt wick or snuff.

which lasted about an eighth part longer than the clear wax. Then followed the aqua vitæ, which lasted about a fifth part longer than the clear wax. Then followed the milk, and water, with little difference from the aqua vitæ, but the water slowest. And in these four last, the wick would spit forth little sparks. For the nitre, it would not hold lighted above some twelve pulses; but all the while it would spit out portions of flame, which afterwards would go out into a vapour. For the brimstone, it would hold lighted much about the same time with the nitre; but then after a little while it would harden and cake about the snaste; so that the mixture of bay-salt with wax will win an eighth part of the time of lasting, and the water a fifth.

370. After the several materials were tried, trial was likewise made of several wicks; as of ordinary cotton, sewing thread, rush, silk, straw, and wood. The silk, straw, and wood would flame a little, till they came to the wax, and then go out: of the other three, the thread consumed faster than the cotton, by a sixth part of time; the cotton next; then the rush consumed slower than the cotton, by at least a third part of time. For the bigness of the flame, the cotton and thread cast a flame much alike: and the rush much less and dimmer. *Quære*, whether wood and wicks both, as in torches, consume faster than the wicks simple.

371. We have spoken of the several materials, and the several wicks: but to the lasting of the flame it importeth also, not only what the material is, but in the same material whether it be hard, soft, old, new, &c. Good housewives, to make their candles burn the longer, use to lay them (one by one) in bran or flour, which make them harder, and so they consume the slower: insomuch as by this means they will outlast other candles of the same stuff almost half in half. For bran and flour have a virtue to harden; so that both age, and lying in the bran, doth help to the lasting. And we see that wax candles last longer than tallow candles, because wax is more firm and hard.

372. The lasting of flame also dependeth upon the easy drawing of the nourishment; as we see in the court of England there is a service which they call *Allnight*; which is (as it were) a great cake of wax, with the wick in the midst; whereby it cometh to pass, that the wick fetcheth the nourishment

further off. We see also that lamps last longer, because the vessel is far broader than the breadth of a taper or candle.

373. Take a turreted lamp of tin, made in the form of a square[1]: the height of the turret being thrice as much as the length of the lower part whereupon the lamp standeth: make only one hole in it, at the end of the return furthest from the turret. Reverse it, and fill it full of oil by that hole; and then set it upright again; and put a wick in at the hole, and lighten it: you shall find that it will burn slow, and a long time: which is caused (as was said last before) for that the flame fetcheth the nourishment afar off. You shall find also, that as the oil wasteth and descendeth, so the top of the turret by little and little filleth with air; which is caused by the rarefaction of the oil by the heat. It were worthy the observation, to make a hole in the top of the turret, and to try when the oil is almost consumed, whether the air made of the oil, if you put to it a flame of a candle, in the letting of it forth will inflame. It were good also to have the lamp made, not of tin, but of glass, that you may see how the vapour or air gathereth by degrees in the top.

374. A fourth point that importeth the lasting of the flame, is the closeness of the air wherein the flame burneth. We see that if wind bloweth upon a candle it wasteth apace. We see also it lasteth longer in a lanthorn than at large. And there are traditions of lamps and candles, that have burnt a very long time in caves and tombs.

375. A fifth point that importeth the lasting of the flame, is the nature of the air where the flame burneth; whether it be cold or hot, moist or dry. The air, if it be very cold, irritateth the flame, and maketh it burn more fiercely (as fire scorcheth in frosty weather) and so furthereth the consumption. The air once heated (I conceive) maketh the flame burn more mildly, and so helpeth the continuance. The air, if it be dry, is indifferent: the air, if it be moist, doth in a degree quench the flame (as we see lights will go out in the damps of mines), and howsoever maketh it burn more dully, and so helpeth the continuance.

Experiments in consort touching burials or infusions of divers bodies in earth.

376. Burials in earth serve for preservation, and for con-

[1] *Squire* in the original.—*J. S.*

densation, and for induration of bodies. And if you intend condensation or induration, you may bury the bodies so as earth may touch them; as if you will make artificial porcelain, &c. And the like you may do for conservation, if the bodies be hard and solid; as clay, wood, &c. But if you intend preservation of bodies more soft and tender, then you must do one of these two: either you must put them in cases, whereby they may not touch the earth; or else you must vault the earth, whereby it may hang over them and not touch them: for if the earth touch them, it will do more hurt by the moisture, causing them to putrefy, than good by the virtual cold, to conserve them; except the earth be very dry and sandy.

377. An orange, lemon, and apple, wrapt in a linen cloth, being buried for a fortnight's space four foot deep within the earth, though it were in a moist place and a rainy time, yet came forth no ways mouldy or rotten, but were become a little harder than they were; otherwise fresh in their colour; but their juice somewhat flatted. But with the burial of a fortnight more they became putrefied.

378. A bottle of beer, buried in like manner as before, became more lively, better tasted, and clearer than it was. And a bottle of wine in like manner. A bottle of vinegar so buried came forth more lively and more odoriferous, smelling almost like a violet. And after the whole month's burial, all the three came forth as fresh and lively, if not better than before.

379. It were a profitable experiment to preserve oranges, lemons, and pomegranates, till summer; for then their price will be mightily increased. This may be done, if you put them in a pot or vessel well covered, that the moisture of the earth come not at them; or else by putting them in a conservatory of snow. And generally, whosoever will make experiments of cold, let him be provided of three things; a conservatory of snow; a good large vault, twenty foot at least under the ground; and a deep well.

380. There hath been a tradition, that pearl, and coral, and turquois-stone, that have lost their colours, may be recovered by burying in the earth; which is a thing of great profit, if it would sort: but upon trial of six weeks' burial, there followed no effect. It were good to try it in a deep well; or in a conservatory of snow, where the cold may be more con-

stringent; and so make the body more united, and thereby more resplendent.

Experiment solitary touching the affects in men's bodies from several winds.

381. Men's bodies are heavier, and less disposed to motion, when southern winds blow than when northern. The cause is, for that when the southern winds blow, the humours do (in some degree) melt and wax fluid, and so flow into the parts; as it is seen in wood and other bodies, which, when the southern winds blow, do swell. Besides, the motion and activity of the body consisteth chiefly in the sinews, which, when the southern wind bloweth, are more relax.[1]

Experiments solitary touching winter and summer sicknesses.

382. It is commonly seen, that more are sick in the summer, and more die in the winter; except it be in pestilent diseases, which commonly reign in summer or autumn. The reason is, because diseases are bred (indeed) chiefly by heat; but then they are cured most by sweat and purge; which in the summer cometh on or is provoked more easily. As for pestilent diseases, the reason why most die of them in summer is because they are bred most in the summer: for otherwise those that are touched are in most danger in the winter.

Experiment solitary touching pestilential seasons.

383. The general opinion is, that years hot and moist are most pestilent; upon the superficial ground that heat and moisture cause putrefaction. In England it is found not true; for many times there have been great plagues in dry years. Whereof the cause may be, for that drought, in the bodies of islanders habituate to moist airs, doth exasperate the humours, and maketh them more apt to putrefy or inflame: besides, it tainteth the waters (commonly), and maketh them less wholesome. And again in Barbary, the plagues break up in the summer months, when the weather is hot and dry.

Experiment solitary touching an error received about epidemical diseases.

384. Many diseases (both epidemical and others) break forth

[1] The statement in this and the next two paragraphs is from Arist. Prob. i. 21. 24. and 25.

at particular times. And the cause is falsely imputed to the constitution of the air at that time when they break forth or reign; whereas it proceedeth (indeed) from a precedent sequence and series of the seasons of the year: and therefore Hippocrates in his prognostics doth make good observations of the diseases that ensue upon the nature of the precedent four seasons of the year.[1]

Experiment solitary touching the alteration or preservation of liquors in wells or deep vaults.

385. Trial hath been made with earthen bottles well stopped, hanged in a well of twenty fathom deep at the least; and some of the bottles have been let down into the water, some others have hanged above, within about a fathom of the water; and the liquors so tried have been beer (not new, but ready for drinking), and wine, and milk. The proof hath been, that both the beer and the wine (as well within the water as above) have not been palled or deaded at all; but as good or somewhat better than bottles of the same drinks and staleness kept in a cellar. But those which did hang above water were apparently the best; and that beer did flower a little; whereas that under water did not, though it were fresh. The milk soured and began to putrefy. Nevertheless it is true, that there is a village near Blois[2], where in deep caves they do thicken milk, in such sort that it becometh very pleasant: which was some cause of this trial of hanging milk in the well: but our proof was naught; neither do I know whether that milk in those caves be first boiled. It were good therefore to try it with milk sodden, and with cream; for that milk of itself is such a compound body, of cream, curds, and whey, as it is easily turned and dissolved. It were good also to try the beer when it is in wort, that it may be seen whether the hanging in the well will accelerate the ripening and clarifying of it.

Experiment solitary touching stutting.[3]

386. Divers, we see, do stut. The cause may be (in most) the refrigeration of the tongue; whereby it is less apt to move.

[1] See Hippocrates, De Aëre, Aquis, et Locis.

[2] The village of St. Gervais, near Blois, still retains its reputation for cream, made probably in the way here described, and probably resembling what is called at Edinburgh Corstophine cream.

[3] See Arist. Prob. xi. 54.

And therefore we see that naturals do generally stut: and we see that in those that stut, if they drink wine moderately, they stut less, because it heateth: and so we see, that they that stut do stut more in the first offer to speak than in continuance, because the tongue is by motion somewhat heated. In some also, it may be (though rarely) the dryness of the tongue; which likewise maketh it less apt to move as well as cold: for it is an affect that cometh to some wise and great men; as it did unto Moses, who was *linguæ præpeditæ*[1]; and many stutters (we find) are very choleric men; choler inducing a dryness in the tongue.

Experiments in consort touching smells.

387. Smells and other odours are sweeter in the air at some distance, than near the nose; as hath been partly touched heretofore. The cause is double: first, the finer mixture or incorporation of the smell: for we see that in sounds likewise, they are sweetest when we cannot hear every part by itself. The other reason is, for that all sweet smells have joined with them some earthy or crude odours; and at some distance the sweet, which is the more spiritual, is perceived, and the earthy reacheth not so far.[2]

388. Sweet smells are most forcible in dry substances when they are broken; and so likewise in oranges or lemons, the nipping off their rind giveth out their smell more: and generally when bodies are moved or stirred, though not broken, they smell more; as a sweet-bag waved. The cause is double: the one, for that there is a greater emission of the spirit when way is made; and this holdeth in the breaking, nipping, or crushing; it holdeth also (in some degree) in the moving: but in this last there is a concurrence of the second cause, which is the impulsion of the air, that bringeth the scent faster upon us.

389. The daintiest smells of flowers are out of those plants whose leaves smell not; as violets, roses, wall-flowers, gilliflowers, pinks, woodbines, vine-flowers, apple-blooms, lime-tree-blooms, bean-blooms, &c. The cause is, for that where there is heat and strength enough in the plant to make the leaves odorate, there the smell of the flower is rather evanid and weaker than that of the leaves; as it is in rosemary flowers, lavender flowers, and sweet-briar roses. But where

[1] Exodus, iv. 10.

[2] Arist. Prob. xii. 1. and 2.

there is less heat, there the spirit of the plant is digested and refined, and severed from the grosser juice, in the efflorescence, and not before.

390. Most odours smell best broken or crushed, as hath been said: but flowers pressed or beaten do leese the freshness and sweetness of their odour.[1] The cause is, for that when they are crushed, the grosser and more earthy spirit cometh out with the finer, and troubleth it; whereas in stronger odours there are no such degrees of the issue of the smell.

Experiments in consort touching the goodness and choice of water.

391. It is a thing of very good use to discover the goodness of waters. The taste, to those that drink water only, doth somewhat: but other experiments are more sure. First, try waters by weight; wherein you may find some difference, though not much; and the lighter you may account the better.

392. Secondly, try them by boiling upon an equal fire; and that which consumeth away fastest, you may account the best.

393. Thirdly, try them in several bottles or open vessels, matches in every thing else, and see which of them last longest without stench or corruption. And that which holdeth unputrefied longest, you may likewise account the best.

394. Fourthly, try them by making drinks stronger or smaller with the same quantity of malt; and you may conclude that that water which maketh the stronger drink is the more concocted and nourishing; though perhaps it be not so good for medicinal use. And such water (commonly) is the water of large and navigable rivers; and likewise in large and clean ponds of standing water; for upon both them the sun hath more power than upon fountains or small rivers. And I conceive that chalk-water is next them the best for going furthest in drink: for that also helpeth concoction; so it be out of a deep well; for then it cureth the rawness of the water; but chalky water, towards the top of the earth, is too fretting; as it appeareth in laundry of clothes, which wear out apace if you use such waters.

395. Fifthly, the housewives do find a difference in waters, for the bearing or not bearing of soap: and it is likely that

[1] Arist. Prob. xxxiii. 3.

the more fat water will bear soap best; for the hungry water doth kill the unctuous nature of the soap.

396. Sixthly, you may make a judgment of waters according to the place whence they spring or come: the rain-water is by the physicians esteemed the finest and the best; but yet it is said to putrefy soonest; which is likely, because of the fineness of the spirit: and in conservatories of rain-water (such as they have in Venice, &c.) they are found not so choice waters; the worse, perhaps, because they are covered aloft, and kept from the sun. Snow-water is held unwholesome; insomuch as the people that dwell at the foot of the snow-mountains, or otherwise upon the ascent, (especially the women,) by drinking of snow-water, have great bags hanging under their throats.[1] Well-water, except it be upon chalk, or a very plentiful spring, maketh meat red; which is an ill sign. Springs on the tops of high hills are the best: for both they seem to have a lightness and appetite of mounting; and besides, they are most pure and unmingled; and again are more percolated through a great space of earth. For waters in valleys join in effect under ground with all waters of the same level; whereas springs on the tops of hills pass though a great deal of pure earth, with less mixture of other waters.

397. Seventhly, judgment may be made of waters by the soil whereupon the water runneth; as pebble is the cleanest and best tasted; and next to that, clay-water; and thirdly, water upon chalk; fourthly, that upon sand; and worst of all upon mud. Neither may you trust waters that taste sweet, for they are commonly found in rising grounds of great cities, which must needs take in a great deal of filth.

Experiment solitary touching the temperate heat under the equinoctial.[2]

398. In Peru, and divers parts of the West Indies, though

[1] Although it is at least very doubtful if snow-water produces the enlargement of the thyroid gland here referred to, yet it is difficult not to believe that elevation above the sea is at least a predisposing cause of the disease. It is found to exist in parts of South America, in which there is no snow, although the height above the sea is much greater than that of the Swiss valleys. Boussingault has suggested a hypothesis,—namely, that the diminished quantity of air which in consequence of diminished atmospherical pressure is contained in water at high levels, may be the cause of the phenomenon.

[2] This paragraph is taken from Acosta's account of the climate of Peru, contained in the second book of his *History of the Indies*. In the *Historia Ventorum* Bacon has often quoted him.

under the line, the heats are not so intolerable as they be in Barbary, and the skirts of the torrid zone. The causes are, first, the great *brizes* which the motion of the air in great circles (such as are under the girdle of the world) produceth; which do refrigerate; and therefore in those parts noon is nothing so hot, when the brizes are great, as about nine or ten of the clock in the forenoon. Another cause is, for that the length of the night, and the dews thereof, do compense the heat of the day. A third cause is the stay of the sun; not in respect of day and night (for that we spake of before), but in respect of the season; for under the line the sun crosseth the line, and maketh two summers and two winters; but in the skirts of the torrid zone it doubleth and goeth back again, and so maketh one long summer.

Experiment solitary touching the coloration of black and tawny Moors.

399. The heat of the sun maketh men black in some countries[1], as in Æthiopia and Ginny, &c. Fire doth it not, as we see in glass-men, that are continually about the fire. The reason may be, because fire doth lick up the spirits and blood of the body, so as they exhale; so that it ever maketh men look pale and sallow; but the sun, which is a gentler heat, doth but draw the blood to the outward parts, and rather concocteth it than soaketh[2] it; and therefore we see that all Æthiopes are fleshy and plump, and have great lips; all which betoken moisture retained, and not drawn out. We see also, that the Negroes are bred in countries that have plenty of water, by rivers or otherwise; for Meroë, which was the metropolis of Æthiopia, was upon a great lake; and Congo, where the Negroes are, is full of rivers. And the confines of the river Niger, where the Negroes also are, are well watered: and the region about Capo Verde is likewise moist, insomuch as it is pestilent through moisture; but the countries of the Abyssenes, and Barbary, and Peru, where they are tawny, and olivaster, and pale, are generally more sandy and dry. As for the Æthiopes, as they are plump and fleshy, so (it may be) they are sanguine and ruddy coloured, if their black skin would suffer it to be seen.

[1] Arist. Prob. xxxviii. 8.
[2] So in the original as in Exp. 346. and in other places.—*J. S*

Experiment solitary touching motion after the instant of death.

400. Some creatures do move a good while after their head is off, as birds; some a very little time, as men and all beasts; some move, though cut in several pieces, as snakes, eels, worms, flies, &c. First, therefore, it is certain, that the immediate cause of death[1] is the resolution or extinguishment of the spirits; and that the destruction or corruption of the organs is but the mediate cause. But some organs are so peremptorily necessary, that the extinguishment of the spirits doth speedily follow; but yet so as there is an interim of a small time. It is reported by one of the ancients, of credit, that a sacrificed beast hath lowed after the heart hath been severed; and it is a report also of credit, that the head of a pig hath been opened, and the brain put into the palm of a man's hand, trembling, without breaking any part of it, or severing it from the marrow of the back-bone, during which time the pig hath been, in all appearance, stark dead, and without motion; and after a small time the brain hath been replaced, and the skull of the pig closed, and the pig hath a little after gone about. And certain it is, that an eye upon revenge hath been thrust forth, so as it hanged a pretty distance by the visual nerve; and during that time the eye hath been without any power of sight; and yet after (being replaced) recovered sight. Now the spirits are chiefly in the head and cells of the brain, which in men and beasts are large; and therefore, when the head is off, they move little or nothing. But birds have small heads, and therefore the spirits are a little more dispersed in the sinews, whereby motion remaineth in them a little longer; insomuch as it is extant in story, that an emperor of Rome, to shew the certainty of his hand, did shoot a great forked arrow at an ostrich[2], as she ran swiftly upon the stage, and struck off her head; and yet she continued the race a little way with her head off.[3] As for worms, and flies, and eels, the spirits are diffused almost all over; and therefore they move in their several pieces.

[1] Arist. Prob. x. 69.
[2] Herodianus, in Commodo.
[3] *Estrich* in the original.—*J. S.*

NATURAL HISTORY.

CENTURY V.

Experiments in consort touching the acceleration of germination.

We will now inquire of plants or vegetables, and we shall do it with diligence. They are the principal part of the third day's work. They are the first *producat*, which is the word of animation; for the other words are but the words of essence. And they are of excellent and general use for food, medicine, and a number of medicinal arts.

401. There was sown in a bed, turnip-seed, radish-seed, wheat, cucumber-seed, and peas. The bed we call a hot-bed, and the manner of it is this: There was taken horse-dung, old and well rotted; this was laid upon a bank half a foot high, and supported round about with planks; and upon the top was cast sifted earth, some two fingers deep; and then the seed sprinkled upon it, having been steeped all night in water mixed with cow-dung. The turnip-seed and the wheat came up half an inch above ground within two days after, without any watering. The rest the third day. The experiment was made in October; and (it may be) in the spring the accelerating would have been the speedier. This is a noble experiment; for without this help they would have been four times as long in coming up. But there doth not occur to me, at this present, any use thereof for profit; except it should be for sowing of peas, which have their price very much increased by the early coming. It may be tried also with cherries, strawberries, and other fruit, which are dearest when they come early.

402. There was wheat steeped in water mixed with cow-dung; other in water mixed with horse-dung; other in water

mixed with pigeon-dung; other in urine of man; other in water mixed with chalk powdered; other in water mixed with soot; other in water mixed with ashes; other in water mixed with bay-salt; other in claret wine; other in malmsey; other in spirit of wine. The proportion of the mixture was a fourth part of the ingredients to the water; save that there was not of the salt above an eighth part. The urine, and wines, and spirit of wine, were simple without mixture of water. The time of steeping was twelve hours. The time of the year October. There was also other wheat sown unsteeped, but watered twice a day with warm water. There was also other wheat sown simple, to compare it with the rest. The event was, that those that were in the mixture of dung, and urine, and soot, chalk, ashes, and salt, came up within six days; and those that afterwards proved the highest, thickest, and most lusty, were, first the urine; and then the dungs; next the chalk; next the soot; next the ashes; next the salt; next the wheat simple of itself, unsteeped and unwatered; next the watered twice a day with warm water, next the claret wine. So that these three last were slower than the ordinary wheat of itself; and this culture did rather retard than advance. As for those that were steeped in malmsey, and spirit of wine, they came not up at all. This is a rich experiment for profit; for the most of the steepings are cheap things; and the goodness of the crop[1] is a great matter of gain, if the goodness of the crop answer the earliness of the coming up; as it is like it will; both being from the vigour of the seed; which also partly appeared in the former experiments, as hath been said. This experiment would be tried in other grains, seeds, and kernels: for it may be some steeping will agree best with some seeds. It would be tried also with roots steeped as before, but for longer time. It would be tried also in several seasons of the year, especially the spring.

403. Strawberries watered now and then (as once in three days) with water wherein hath been steeped sheep's-dung or pigeon's-dung, will prevent and come early. And it is like the same effect would follow in other berries, herbs, flowers, grains, or trees. And therefore it is an experiment, though vulgar in strawberries, yet not brought into use generally: for it is usual

[1] So in the original. The words *goodness of the crop* have apparently been substituted by accident for *acceleration of the growth*, or some equivalent expression; the transcriber's eye catching them from the line below. — *J. S.*

to help the ground with muck; and likewise to recomfort it sometimes with muck put to the roots; but to water it with muck water, which is like to be more forcible, is not practised.

404. Dung, or chalk, or blood, applied in substance (seasonably) to the roots of trees, doth set them forwards. But to do it unto herbs, without mixture of water or earth, it may be these helps are too hot.

405. The former means of helping germination, are either by the goodness and strength of the nourishment; or by the comforting and exciting the spirits in the plant, to draw the nourishment better. And of this latter kind, concerning the comforting of the spirits of the plant, are also the experiments that follow; though they be not applications to the root or seed. The planting of trees warm upon a wall against the south or south-east sun, doth hasten their coming on and ripening; and the south-east is found to be better than the south-west, though the south-west be the hotter coast. But the cause is chiefly, for that the heat of the morning succeedeth the cold of the night: and partly, because (many times) the south-west sun is too parching. So likewise the planting of them upon the back of a chimney where a fire is kept, doth hasten their coming on and ripening; nay more, the drawing of the boughs into the inside of a room where a fire is continually kept, worketh the same effect; which hath been tried with grapes; insomuch as they will come a month earlier than the grapes abroad.

406. Besides the two means of accelerating germination formerly described; that is to say, the mending of the nourishment, and comforting of the spirit of the plant; there is a third; which is the making way for the easy coming to the nourishment and drawing it. And therefore gentle digging and loosening of the earth about the roots of trees; and the removing herbs and flowers into new earth, once in two years, (which is the same thing, for the new earth is ever looser,) doth greatly further the prospering and earliness of plants.

407. But the most admirable acceleration by facilitating the nourishment is that of water. For a standard of a damask rose with the root on, was set in a chamber where no fire was, upright in an earthen pan full of fair water without any mixture, half a foot under the water, the standard being more than two foot high above the water: within the space of ten days the standard did put forth a fair green leaf, and some other

little buds, which stood at a stay, without any shew of decay or withering, more than seven days. But afterwards that leaf faded, but the young buds did sprout on; which afterward opened into fair leaves, in the space of three months; and continued so a while after, till upon removal we left the trial. But note, that the leaves were somewhat paler and lighter-coloured than the leaves use to be abroad. Note that the first buds were in the end of October; and it is likely that if it had been in the spring time, it would have put forth with greater strength, and (it may be) to have grown on to bear flowers. By this means you may have (as it seemeth) roses set in the midst of a pool, being supported by some stay; which is matter of rareness and pleasure, though of small use. This is the more strange, for that the like rose-standard was put at the same time into water mixed with horse-dung, the horse-dung about the fourth part to the water, and in four months' space (while it was observed) put not forth any leaf, though divers buds at the first, as the other.

408. A Dutch flower, that had a bulbous root, was likewise put at the same time all under water, some two or three fingers deep; and within seven days sprouted, and continued long after further growing. There were also put in, a beet-root, a borage root, and a radish-root, which had all their leaves cut almost close to the roots; and within six weeks had fair leaves, and so continued till the end of November.

409. Note that if roots, or peas, or flowers, may be accelerated in their coming and ripening, there is a double profit; the one in the high price that those things bear when they come early; the other in the swiftness of their returns: for in some grounds which are strong, you shall have a radish, &c., come in a month, that in other grounds will not come in two; and so make double returns.

410. Wheat also was put into the water, and came not forth at all; so as it seemeth there must be some strength and bulk in the body put into the water, as it is in roots; for grains, or seeds, the cold of the water will mortify. But casually some wheat lay under the pan, which was somewhat moistened by the suing of the pan; which in six weeks (as aforesaid) looked mouldy to the eye, but it was sprouted forth half a finger's length.

411. It seemeth by these instances of water, that for nou-

rishment the water is almost all in all, and that the earth doth but keep the plant upright, and save it from over-heat and over-cold; and therefore is a comfortable experiment for good drinkers. It proveth also that our former opinion; that drink incorporate with flesh or roots (as in capon-beer, &c.) will nourish more easily than meat and drink taken severally.

412. The housing of plants (I conceive) will both accelerate germination, and bring forth flowers and plants in the colder seasons: and as we house hot-country plants, as lemons, oranges, myrtles, to save them; so we may house our own country plants, to forward them, and make them come in the cold seasons; in such sort, that you may have violets, strawberries, peas, all winter; so that you sow or remove them at fit times. This experiment is to be referred unto the comforting of the spirit of the plant by warmth, as well as housing their boughs, &c. So then the means to accelerate germination are in particular eight, in general three.

Experiments in consort touching the putting back or retardation of germination.[1]

413. To make roses or other flowers come late, it is an experiment of pleasure. For the ancients esteemed much of *rosa sera.*[2] And indeed the November-rose is the sweetest, having been less exhaled by the sun. The means are these. First, the cutting off their tops immediately after they have done bearing; and then they will come again the same year about November: but they will not come just on the tops where they were cut, but out of those shoots which were (as it were) *water-boughs.* The cause is, for that the sap, which otherwise would have fed the top (though after bearing), will by the discharge of that divert unto the side-sprouts; and they will come to bear, but later.

414. The second is the pulling off the buds of the rose, when they are newly knotted; for then the side-branches will bear. The cause is the same with the former; for cutting off the tops, and pulling off the buds, work the same effect, in retention of the sap for a time, and diversion of it to the sprouts that were not so forward.

415. The third is the cutting off some few of the top-boughs

[1] Compare the precepts here given with those in Porta's *Natural Magic*, iii. 10.
[2] Horace, Odes, i. 38.

in the spring-time, but suffering the lower boughs to grow on. The cause is, for that the boughs do help to draw up the sap more strongly; and we see that in polling of trees, many do use to leave a bough or two on the top, to help to draw up the sap. And it is reported also, that if you graft upon the bough of a tree, and cut off some of the old boughs, the new scions[1] will perish.

416. The fourth is by laying the roots bare about Christmas, some days. The cause is plain, for that it doth arrest the sap from going upwards for a time; which arrest is afterwards released by the covering of the root again with earth; and then the sap getteth up, but later.

417. The fifth is the removing of the tree, some month before it buddeth. The cause is, for that some time will be required after the remove for the re-settling, before it can draw the juice; and that time being lost, the blossom must needs come forth later.

418. The sixth is the grafting of roses in May, which commonly gardeners do not till July; and then they bear not till the next year; but if you graft them in May, they will bear the same year, but late.

419. The seventh is the girding of the body of the tree about with some pack-thread; for that also in a degree restraineth the sap, and maketh it come up more late and more slowly.

420. The eighth is the planting of them in a shade, or in a hedge; the cause is, partly the keeping out of the sun, which hasteneth the sap to rise; and partly the robbing of them of nourishment by the stuff in the hedge. These means may be practised upon other, both trees and flowers, *mutatis mutandis*.

421. Men have entertained a conceit that sheweth prettily; namely, that if you graft a late-coming fruit upon a stock of a fruit-tree that cometh early, the graft will bear fruit early; as a peach upon a cherry; and contrariwise, if an early coming fruit upon a stock of a fruit-tree that cometh late, the graft will bear fruit late; as a cherry upon a peach. But these are but imaginations, and untrue.[2] The cause is, for that the scion over-ruleth the stock quite, and the stock is but passive only, and giveth aliment, but no motion, to the graft.

[1] *Cions* in the original, both here and in Exp. 421.; and so the word is spelt throughout the volume, in the singular (*a cions*) as well as in the plural. —*J. S.*

[2] See Porta, ubi supra.

Experiments in consort touching the melioration of fruits, trees, and plants.

We will speak now, how to make fruits, flowers, and roots larger, in more plenty, and sweeter, than they use to be; and how to make the trees themselves more tall, more spread, and more hasty and sudden, than they use to be. Wherein there is no doubt but the former experiments of acceleration will serve much to these purposes; and again, that these experiments which we shall now set down, do serve also for acceleration; because both effects proceed from the increase of vigour in the tree. But yet to avoid confusion, and because some of the means are more proper for the one effect and some for the other, we will handle them apart.

422. It is an assured experience, that an heap of flint or stone, laid about the bottom of a wild tree, (as an oak, elm, ash, &c.,) upon the first planting, doth make it prosper double as much as without it. The cause is, for that it retaineth the moisture which falleth at any time upon the tree, and suffereth it not to be exhaled by the sun. Again it keepeth the tree warm from cold blasts and frosts, as it were in an house. It may be also there is somewhat in the keeping of it steady at the first. *Quære*, If laying of straw some height about the body of a tree, will not make the tree forwards. For though the root giveth the sap, yet it is the body that draweth it. But you must note, that if you lay stones about the stalk of lettuce, or other plants that are more soft, it will over-moisten the roots, so as the worms will eat them.

423. A tree, at the first setting, should not be shaken, until it hath taken root fully: and therefore some have put two little forks about the bottom of their trees to keep them upright; but after a year's rooting, then shaking doth the tree good, by loosening of the earth, and (perhaps) by exercising, as it were, and stirring the sap of the tree.

424. Generally the cutting away of boughs and suckers at the root and body doth make trees grow high; and contrariwise, the polling and cutting of the top maketh them grow spread and bushy: as we see in pollards, &c.

425. It is reported, that to make hasty-growing coppice woods, the way is, to take willow, sallow, poplar, alder, of some

seven years' growth; and to set them, not upright but aslope, a reasonable depth under the ground; and then instead of one root they will put forth many, and so carry more shoots upon a stem.

426. When you would have many new roots of fruit-trees, take a low tree, and bow it, and lay all his branches aflat upon the ground, and cast earth upon them; and every twig will take root.[1] And this is a very profitable experiment for costly trees, (for the boughs will make stocks without charge,) such as are apricots, peaches, almonds, cornelians, mulberries, figs, &c. The like is continually practised with vines, roses, musk-roses, &c.

427. From May to July you may take off the bark of any bough, being of the bigness of three or four inches, and cover the bare place, somewhat above and below, with loam well tempered with horse-dung, binding it fast down. Then cut off the bough about Alhallontide in the bare place, and set it in the ground; and it will grow to be a fair tree in one year. The cause may be, for that the baring from the bark keepeth the sap from descending towards winter, and so holdeth it in the bough; and it may be also that the loam and horse-dung applied to the bare place do moisten it and cherish it, and make it more apt to put forth the root. Note, that this may be a general means for keeping up the sap of trees in their boughs; which may serve to other effects.

428. It hath been practised in trees that show fair and bear not, to bore a hole through the heart of the tree, and thereupon it will bear. Which may be, for that the tree before hath too much repletion, and was oppressed with its own sap; for repletion is an enemy to generation.[2]

429. It hath been practised in trees that do not bear, to cleave two or three of the chief roots, and to put into the cleft a small pebble, which may keep it open, and then it will bear. The cause may be, for that a root of a tree may be (as it were) hide-bound, no less than the body of the tree; but it will *not* keep open without somewhat put into it.

430. It is usually practised, to set trees that require much sun upon walls against the south; as apricots, peaches, plums, vines, figs, and the like. It hath a double commodity; the

[1] Compare Xen. Œcon. xix.

[2] For this and the next paragraph, see Porta, *Villæ*, v. 3.

one, the heat of the wall by reflexion; the other, the taking away of the shade; for when a tree groweth round, the upper boughs over-shadow the lower: but when it is spread upon a wall, the sun cometh alike upon the upper and lower branches.

431. It hath also been practised (by some) to pull off some leaves from the trees so spread, that the sun may come upon the bough and fruit the better. There hath been practised also a curiosity, to set a tree upon the north side of a wall, and at a little height to draw him through the wall, and spread him upon the south side: conceiving that the root and lower part of the stock should enjoy the freshness of the shade; and the upper boughs and fruit, the comfort of the sun. But it sorted not; the cause is, for that the root requireth some comfort from the sun, though under earth, as well as the body: and the lower part of the body more than the upper, as we see in compassing a tree below with straw.

432. The lowness of the bough where the fruit cometh, maketh the fruit greater, and to ripen better; for you shall ever see, in apricots, peaches, or melocotones[1], upon a wall, the greatest fruits towards the bottom. And in France, the grapes that make the wine, grow upon low vines bound to small stakes; and the raised vines in arbours make but verjuice. It is true, that in Italy and other countries where they have hotter sun, they raise them upon elms and trees; but I conceive, that if the French manner of planting low were brought in use there, their wines would be stronger and sweeter. But it is more chargeable in respect of the props. It were good to try whether a tree grafted somewhat near the ground, and the lower boughs only maintained, and the higher continually pruned[2] off, would not make a larger fruit.

433. To have fruit in greater plenty, the way is to graft not only upon young stocks, but upon divers boughs of an old tree; for they will bear great numbers of fruit: whereas if you graft but upon one stock, the tree can bear but few.

434. The digging yearly about the roots of trees, which is a great means both to the acceleration and melioration of fruits, is practised in nothing but in vines; which if it were transferred unto other trees and shrubs (as roses, &c.), I conceive would advance them likewise.

[1] That is, the quince, *μῆλον κυδώνιον*.
[2] *Proined* in the original. — *J. S.*

435. It hath been known, that a fruit-tree hath been blown up almost by the roots, and set up again, and the next year bare exceedingly. The cause of this was nothing but the loosening of the earth, which conforteth any tree, and is fit to be practised more than it is in fruit-trees: for trees cannot be so fitly removed into new grounds, as flowers and herbs may.

436. To revive an old tree, the digging of it about the roots, and applying new mould to the roots, is the way. We see also that draught-oxen put into fresh pasture gather new and tender flesh; and in all things, better nourishment than hath been used doth help to renew; especially if it be not only better, but changed, and differing from the former.

437. If an herb be cut off from the roots in the beginning of winter, and then the earth be trodden and beaten down hard with the foot and spade, the roots will become of very great magnitude in summer. The reason is, for that the moisture, being forbidden to come up in the plant, stayeth longer in the root, and so dilateth it. And gardeners use to tread down any loose ground, after they have sown onions, or turnips, &c.

438. If *panicum* be laid below and about the bottom of a root, it will cause the root to grow to an excessive bigness.[1] The cause is, for that being itself of a spongy substance, it draweth the moisture of the earth to it, and so feedeth the root. This is of greatest use for onions, turnips, parsnips, and carrots.

439. The shifting of ground is a means to better the tree and fruit; but with this caution, that all things do prosper best when they are advanced to the better. Your nursery of stocks ought to be in a more barren ground than the ground is whereunto you remove them. So all graziers prefer their cattle from meaner pastures to better. We see also, that hardness in youth lengtheneth life, because it leaveth a cherishing to the better of the body in age: nay, in exercises, it is good to begin with the hardest, as dancing in thick shoes, &c.

440. It hath been observed, that hacking of trees in their bark, both downright and across, so as you make them rather in slices than in continued hacks, doth great good to trees, and especially delivereth them from being hide-bound, and killeth their moss.

[1] Arist. Prob. xx. 6. But Aristotle is only speaking of the root of the selinum.

441. Shade to some plants conduceth to make them large and prosperous more than sun; as in strawberries and bays, &c. Therefore amongst strawberries sow here and there some borage-seed, and you shall find the strawberries under those leaves far more large than their fellows. And bays you must plant to the north, or defend them from the sun by a hedge-row; and when you sow the berries, weed not the borders for the first half year; for the weed giveth them shade.

442. To increase the crops of plants, there would be considered not only the increasing the lust of the earth or of the plant, but the saving also of that which is spilt. So they have lately made a trial to set wheat; which nevertheless hath been left off, because of the trouble and pains: yet so much is true, that there is much saved by the setting, in comparison of that which is sown, both by keeping it from being picked up by birds, and by avoiding the shallow lying of it, whereby much that is sown taketh no root.

443. It is prescribed by some of the ancients, that you take small trees, upon which figs or other fruit grow, being yet unripe, and cover the trees in the middle of autumn with dung, until the spring; and then take them up in a warm day, and replant them in good ground; and by that means the former year's tree will be ripe, as by a new birth, when other trees of the same kind do but blossom.[1] But this seemeth to have no great probability.

444. It is reported, that if you take nitre, and mingle it with water to the thickness of honey, and therewith anoint the bud after the vine is cut, it will sprout forth within eight days. The cause is like to be, (if the experiment be true,) the opening of the bud and of the parts contiguous, by the spirit of the nitre; for nitre is (as it were) the life of vegetables.

445. Take seed or kernels of apples, pears, oranges; or a peach, or a plum-stone, &c., and put them into a squill, (which is like a great onion,) and they will come up much earlier than in the earth itself. This I conceive to be as a kind of grafting in the root; for as the stock of a graft yieldeth better prepared nourishment to the graft than the crude earth, so the squill doth the like to the seed. And I suppose the same would be done by putting kernels into a turnip or the like; save that the

[1] Pliny, xv. 19. This paragraph and those which follow it, to 448. inclusive, are taken from Porta, *Nat. Mag.* iii. 8.

squill is more vigorous and hot. It may be tried also with putting onion-seed into an onion-head, which thereby (perhaps) will bring forth a larger and earlier onion.

446. The pricking of a fruit in several places, when it is almost at his bigness, and before it ripeneth, hath been practised with success, to ripen the fruit more suddenly. We see the example of the biting of wasps or worms upon fruit, whereby it manifestly ripeneth the sooner.

447. It is reported, that *alga marina* (sea-weed), put under the roots of coleworts, and (perhaps) of other plants, will further their growth. The virtue (no doubt) hath relation to salt, which is a great help to fertility.

448. It hath been practised, to cut off the stalks of cucumbers, immediately after their bearing, close by the earth; and then to cast a pretty quantity of earth upon the plant that remaineth; and they will bear the next year fruit long before the ordinary time. The cause may be, for that the sap goeth down the sooner, and is not spent in the stalk or leaf, which remaineth after the fruit. Where note, that the dying in the winter of the roots of plants that are annual, seemeth to be partly caused by the over-expence of the sap into stalk and leaves; which being prevented, they will super-annuate[1], if they stand warm.

449. The pulling off many of the blossoms from a fruit-tree doth make the fruit fairer. The cause is manifest; for that the sap hath the less to nourish. And it is a common experience, that if you do not pull off some blossoms the first time a tree bloometh, it will blossom itself to death.

450. It were good to try what would be the effect, if all the blossoms were pulled from a fruit-tree, or the acorns and chestnut-buds, &c. from a wild tree, for two years together. I suppose that the tree will either put forth the third year bigger and more plentiful fruit; or else, the same years, larger leaves, because of the sap stored up.

451. It hath been generally received, that a plant watered with warm water will come up sooner and better than with cold water or with showers.[2] But our experiment of watering wheat with warm water (as hath been said) succeeded not; which may be, because the trial was too late in the year, viz. in the end of October. For the cold then coming upon the

[1] *Super-annate* in the original. — *J. S.*

[2] Porta, ubi supra.

seed, after it was made more tender by the warm water, might check it.

452. There is no doubt, but that grafting (for the most part) doth meliorate the fruit. The cause is manifest; for that the nourishment is better prepared in the stock than in the crude earth; but yet note well, that there be some trees that are said to come up more happily from the kernel than from the graft; as the peach and melocotone. The cause I suppose to be, for that those plants require a nourishment of great moisture; and though the nourishment of the stock be finer and better prepared, yet it is not so moist and plentiful as the nourishment of the earth. And indeed we see those fruits are very cold fruits in their nature.

453. It hath been received, that a smaller pear grafted upon a stock that beareth a greater pear, will become great. But I think it is as true as that of the prime-fruit upon the late stock, and *e converso;* which we rejected before; for the scions will govern. Nevertheless it is probable enough, that if you can get a scion to grow upon a stock of another kind, that is much moister than his own stock, it may make the fruit greater, because it will yield more plentiful nourishment; though it is like it will make the fruit baser. But generally the grafting is upon a drier stock; as the apple upon a crab, the pear upon a thorn, &c. Yet it is reported, that in the Low Countries they will graft an apple-scion upon the stock of a colewort, and it will bear a great flaggy apple, the kernel of which, if it be set, will be a colewort, and not an apple. It were good to try whether an apple-scion will prosper, if it be grafted upon a sallow, or upon a poplar, or upon an alder, or upon an elm, or upon an horse-plum, which are the moistest of trees. I have heard that it hath been tried upon an elm, and succeeded.

454. It is manifest by experience that flowers removed wax greater, because the nourishment is more easily come by in the loose earth. It may be, that oft regrafting of the same scion may likewise make fruit greater; as if you take a scion and graft it upon a stock the first year, and then cut it off and graft it upon another stock the second year, and so for a third or fourth year, and then let it rest, it will yield afterward, when it beareth, the greater fruit.

Of grafting there are many experiments worth the noting, but those we reserve to a proper place.

455. It maketh figs better, if a fig-tree, when it beginneth to put forth leaves, have his top cut off.[1] The cause is plain, for that the sap hath the less to feed, and the less way to mount: but it may be the fig will come somewhat later, as was formerly touched. The same may be tried likewise in other trees.

456. It is reported, that mulberries will be fairer, and the trees more fruitful, if you bore the trunk of the tree through in several places, and thrust into the places bored wedges of some hot trees, as turpentine, mastic-tree, guaiacum, juniper, &c. The cause may be, for that adventive heat doth cheer up the native juice of the tree.

457. It is reported, that trees will grow greater, and bear better fruit, if you put salt, or lees of wine, or blood to the root. The cause may be the increasing the lust or spirit of the root; these things being more forcible than ordinary composts.

458. It is reported by one of the ancients[2] that artichokes will be less prickly and more tender, if the seeds have their tops dulled or grated off upon a stone.

459. Herbs will be tenderer and fairer, if you take them out of beds, when they are newly come up, and remove them into pots, with better earth. The remove from bed to bed was spoken of before; but that was in several years; this is upon the sudden. The cause is the same with other removes formerly mentioned.

460. Coleworts are reported by one of the ancients to prosper exceedingly, and to be better tasted, if they be sometimes watered with salt water; and much more with water mixed with nitre[3]; the spirit of which is less adurent than salt.

461. It is reported that cucumbers will prove more tender and dainty, if their seeds be steeped a little in milk; the cause may be, for that the seed being mollified with the milk, will be too weak to draw the grosser juice of the earth, but only the finer. The same experiments may be made in artichokes and other seeds, when you would take away either their flashiness or bitterness. They speak also, that the like effect followeth of steeping in water mixed with honey; but that seemeth to me not so probable, because honey hath too quick a spirit.

462. It is reported that cucumbers will be less watery, and

[1] Porta, Nat. Mag. iii. 19. The following paragraphs, to 462. inclusive, are from the same chapter.

[2] Varro, Geopon. xii. 39.

[3] Columella is Porta's authority for this.

more melon-like, if in the pit where you set them, you fill it (half way up) with chaff or small sticks, and then pour earth upon them: for cucumbers, as it seemeth, do extremely affect moisture, and over-drink themselves; which this chaff or chips forbiddeth. Nay, it is further reported, that if, when a cucumber is grown, you set a pot of water about five or six inches distance from it, it will in twenty-four hours shoot so much out as to touch the pot; which, if it be true, it is an experiment of an higher nature than belongeth to this title: for it discovereth perception in plants to move towards that which should help and comfort them, though it be at a distance. The ancient tradition of the vine is far more strange: it is, that if you set a stake or prop some distance from it, it will grow that way; which is far stranger (as is said) than the other; for that water may work by a sympathy of attraction; but this of the stake seemeth to be a reasonable discourse.

463. It hath been touched before, that terebration of trees doth make them prosper better. But it is found also that it maketh the fruit sweeter and better. The cause is, for that notwithstanding the terebration, they may receive aliment sufficient, and yet no more than they can well turn and digest; and withal do sweat out the coarsest and unprofitablest juice[1]; even as it is in living creatures, which by moderate feeding, and exercise, and sweat, attain the soundest habit of body.

464. As terebration doth meliorate fruit, so upon the like reason doth letting of plants blood; as pricking vines or other trees, after they be of some growth; and thereby letting forth gum or tears; though this be not to continue, as it is in terebration, but at some seasons. And it is reported that by this artifice bitter almonds have been turned into sweet.

465. The ancients for the dulcorating of fruit do commend swine's dung above all other dung: which may be because of the moisture of that beast, whereby the excrement hath less acrimony; for we see swine's and pig's flesh is the moistest of fleshes.

466. It is observed by some, that all herbs wax sweeter,

[1] "Noxium desudant humorem, ut in animalibus sæpenumero perspicere licet."—Porta, *Nat. Mag.* iii. 17.

The following paragraphs, to 467. inclusive, are from the same chapter, and the next three, to 470. inclusive, from the eleventh chapter of the same book.

both in smell and taste, if after they be grown up some reasonable time they be cut, and so you take the latter sprout. The cause may be, for that the longer the juice stayeth in the root and stalk, the better it concocteth. For one of the chief causes why grains, seeds, and fruits, are more nourishing than leaves, is the length of time in which they grow to maturation. It were not amiss to keep back the sap of herbs, or the like, by some fit means, till the end of summer; whereby (it may be) they will be more nourishing.

467. As grafting doth generally advance and meliorate fruits, above that which they would be if they were set of kernels or stones, in regard the nourishment is better concocted; so (no doubt) even in grafting, for the same cause, the choice of the stock doth much; always provided that it be somewhat inferior to the scion; for otherwise it dulleth it. They commend much the grafting of pears or apples upon a quince.

468. Besides the means of melioration of fruits before mentioned, it is set down as tried, that a mixture of bran and swines-dung, or chaff and swines-dung, (especially laid up together for a month to rot) is a very great nourisher and comforter to a fruit-tree.

469. It is delivered, that onions wax greater if they be taken out of the earth, and laid a drying twenty days, and then set again; and yet more, if the outermost pill be taken off all over.

470. It is delivered by some, that if one take the bough of a low fruit-tree newly budded, and draw it gently, without hurting it, into an earthen pot perforate at the bottom to let in the plant, and then cover the pot with earth, it will yield a very large fruit within the ground. Which experiment is nothing but potting of plants without removing, and leaving the fruit in the earth. The like (they say) will be effected by an empty pot without earth in it, put over a fruit, being propped up with a stake, as it hangeth upon the tree; and the better, if some few pertusions be made in the pot. Wherein, besides the defending of the fruit from extremity of sun or weather, some give a reason, that the fruit, loving and coveting the open air and sun, is invited by those pertusions to spread and approach as near the open air as it can; and so enlargeth in magnitude.

471. All trees in high and sandy grounds, are to be set deep; and in watery grounds, more shallow. And in all trees, when they be removed, (especially fruit-trees) care ought to be taken that the sides of the trees be coasted (north and south, &c.) as they stood before.[1] The same is said also of stone out of the quarry, to make it more durable; though that seemeth to have less reason; because the stone lieth not so near the sun, as the tree groweth.

472. Timber trees in a coppice wood do grow better than in an open field; both because they offer not to spread so much, but shoot up still in height; and chiefly because they are defended from too much sun and wind, which do check the growth of all fruit; and so (no doubt) fruit-trees, or vines, set upon a wall against the sun, between elbows or buttresses of stone, ripen more than upon a plain wall.

473. It is said, that if potado-roots be set in a pot filled with earth, and then the pot with earth be set likewise within the ground some two or three inches, the roots will grow greater than ordinary. The cause may be, for that having earth enough within the pot to nourish them, and then being stopped by the bottom of the pot from putting strings downward, they must needs grow greater in breadth and thickness. And it may be, that all seeds or roots, potted and so set into the earth, will prosper the better.

474. The cutting off the leaves of radish, or other roots, in the beginning of winter, before they wither, and covering again the root something high with earth, will preserve the root all winter, and make it bigger in the spring following, as hath been partly touched before. So that there is a double use of this cutting off the leaves; for in plants where the root is the esculent, as radish and parsnips, it will make the root the greater; and so it will do to the heads of onions. And where the fruit is the esculent, by strengthening the root, it will make the fruit also the greater.

475. It is an experiment of great pleasure, to make the leaves of shady trees larger than ordinary. It hath been tried (for certain) that a scion of a weech-elm, grafted upon the stock of an ordinary elm, will put forth leaves almost as broad as the brim of one's hat. And it is very likely, that as in fruit-trees the graft maketh a greater fruit; so in

[1] Porta, Villæ, lii. 14. and 16.

trees that bear no fruit, it will make the greater leaves. It would be tried therefore in trees of that kind chiefly, as birch, asp, willow; and especially the shining willow, which they call swallow-tail, because of the pleasure of the leaf.

476. The barrenness of trees by accident, (besides the weakness of the soil, seed, or root, and the injury of the weather,) cometh either of their over-growing with moss, or their being hide-bound, or their planting too deep, or by issuing of the sap too much into the leaves. For all these there are remedies mentioned before.

Experiments in consort touching compound fruits and flowers.

We see that in living creatures, that have male and female, there is copulation of several kinds; and so compound creatures; as the mule, that is generated betwixt the horse and the ass; and some other compounds which we call monsters, though more rare; and it is held that that proverb, *Africa semper aliquid monstri parit* [1], cometh, for that the fountains of waters there being rare, divers sorts of beasts come from several parts to drink; and so being refreshed, fall to couple, and many times with several kinds. The compounding or mixture of kinds in plants is not found out; which nevertheless, if it be possible, is more at command than that of living creatures, for that their lust requireth a voluntary motion; wherefore it were one of the most noble experiments touching plants to find it out: for so you may have great variety of new fruits and flowers yet unknown. Grafting doth it not. That mendeth the fruit, or doubleth the flowers, &c., but it hath not the power to make a new kind. For the scion ever over-ruleth the stock.

477. It hath been set down by one of the ancients, that if you take two twigs of several fruit-trees, and flat them on the sides, and then bind them close together and set them in the ground, they will come up in one stock; but yet they will put forth their several fruits without any commixture in the fruit. Wherein note (by the way) that unity of continuance is easier to procure than unity of species. It is reported also that vines of red and white grapes, being set in the ground, and the upper

[1] Erasm. Adag. iii. 7. 10.

parts being flatted and bound close together, will put forth grapes of the several colours upon the same branch, and grapestones of several colours within the same grape; but the more after a year or two; the unity (as it seemeth) growing more perfect. And this will likewise help, if from the first uniting they be often watered; for all moisture helpeth to union. And it is prescribed also to bind the bud as soon as it cometh forth, as well as the stock; at the least for a time.[1]

478. They report that divers seeds, put into a clout and laid in earth well dunged, will put up plants contiguous; which afterwards being bound in, their shoots will incorporate. The like is said of kernels put into a bottle with a narrow mouth, filled with earth.

479. It is reported that young trees of several kinds, set contiguous without any binding, and very often watered, in a fruitful ground, with the very luxury of the trees will incorporate and grow together. Which seemeth to me the likeliest means that hath been propounded; for that the binding doth hinder the natural swelling of the tree; which, while it is in motion, doth better unite.

Experiments in consort touching the sympathy and antipathy of plants.

There are many ancient and received traditions and observations touching the sympathy and antipathy of plants; for that some will thrive best growing near others; which they impute to sympathy; and some worse; which they impute to antipathy. But these are idle and ignorant conceits, and forsake the true indication of the causes; as the most part of experiments that concern sympathies and antipathies do. For as to plants, neither is there any such secret friendship or hatred as they imagine; and if we should be content to call it sympathy and antipathy, it is utterly mistaken; for their sympathy is an antipathy, and their antipathy is a sympathy: for it is thus; Wheresoever one plant draweth such a particular juice out of the earth, as it qualifieth the earth, so as that juice which remaineth is fit for the other plant; there the neighbourhood doth good; because the nourishments are contrary or several: but where two plants

[1] Porta, Nat. Mag. iii. 4. The next two paragraphs are from the fifth chapter.

draw much the same juice, there the neighbourhood hurteth; for the one deceiveth the other.[1]

480. First therefore, all plants that do draw much nourishment from the earth, and so soak[2] the earth and exhaust it, hurt all things that grow by them; as great trees, (especially ashes) and such trees as spread their roots near the top of the ground. So the colewort is not an enemy, (though that were anciently received,) to the vine only[3]; but it is an enemy to any other plant; because it draweth strongly the fattest juice of the earth. And if it be true that the vine, when it creepeth near the colewort, will turn away; this may be because there it findeth worse nourishment; for though the root be where it was, yet (I doubt) the plant will bend as it nourisheth.

481. Where plants are of several natures, and draw several juices out of the earth, there (as hath been said) the one set by the other helpeth: as it is set down by divers of the ancients, that rue doth prosper much, and becometh stronger, if it be set by a fig-tree[4]; which (we conceive) is caused not by reason of friendship, but by extraction of a contrary juice; the one drawing juice fit to result sweet, the other bitter. So they have set down likewise, that a rose set by garlic is sweeter[5]: which likewise may be, because the more fetid juice of the earth goeth into the garlic, and the more odorate into the rose.

482. This we see manifestly, that there be certain cornflowers which come seldom or never in other places, unless they be set, but only amongst corn: as the blue-bottle, a kind of yellow marygold, wild poppy, and fumitory. Neither can this be by reason of the culture of the ground, by ploughing or furrowing; as some herbs and flowers will grow but in ditches new cast; for if the ground lie fallow and unsown, they will not come: so as it should seem to be the corn that qualifieth the earth, and prepareth it for their growth.

483. This observation, if it holdeth, (as it is very probable,)

[1] This explanation is proposed by Fracastorius, *De Sympathiâ et Antipathiâ*, p. 46.; and it appears the most probable that has been hitherto suggested.

[2] *Soake* in the original. The word occurs so often in a similar context, that I suppose it may be considered as another form of the word *suck*. — *J. S.*

[3] Pliny, xxiv. 1. It is probable that the colewort, like the vine, requires a large supply of potash. A similar circumstance has led to a popular saying in South America that the cocoa-nut palm likes to listen to the human voice; the truth being, that it thrives near human habitations, where the soil contains a larger proportion of soda than elsewhere.

[4] Pliny, xix. 45.

[5] Porta, Nat. Mag. iii. 16.

is of great use for the meliorating of taste in fruits and esculent herbs, and of the scent of flowers. For I do not doubt, but if the fig-tree do make the rue more strong and bitter (as the ancients have noted), good store of rue planted about the fig-tree will make the fig more sweet. Now the tastes that do most offend in fruits and herbs and roots, are bitter, harsh, sour, and waterish or flashy. It were good therefore to make the trials following.

484. Take wormwood, or rue, and set it near lettuce, or coleflory, or artichoke; and see whether the lettuce, or the coleflory, &c., become not the sweeter.

485. Take a service-tree, or a cornelian-tree, or an elder-tree, which we know have fruits of harsh and binding juice, and set them near a vine or fig-tree, and see whether the grapes or figs will not be the sweeter.

486. Take cucumbers or pumpions, and set them (here and there) amongst musk-melons, and see whether the melons will not be more winy, and better tasted. Set cucumbers likewise amongst radish, and see whether the radish will not be made the more biting.

487. Take sorrel, and set it amongst rasps, and see whether the rasps will not be the sweeter.

488. Take common briar, and set it amongst violets or wall-flowers, and see whether it will not make the violets or wall-flowers sweeter, and less earthy in their smell. So set lettuce or cucumbers amongst rosemary or bays, and see whether the rosemary or bays will not be the more odorate or aromatical.

489. Contrariwise, you must take heed how you set herbs together, that draw much the like juice. And therefore I think rosemary will leese in sweetness, if it be set with lavender or bays, or the like. But yet if you will correct the strength of an herb, you shall do well to set other like herbs by him to take him down; as if you should set tansey by angelica, it may be the angelica would be the weaker, and fitter for mixture in perfume. And if you should set rue by common wormwood, it may be the wormwood would turn to be liker Roman wormwood.

490. This axiom is of large extent; and therefore would be severed and refined by trial. Neither must you expect to have a gross difference by this kind of culture, but only further perfection.

491. Trial would be also made in herbs poisonous and

purgative, whose ill quality perhaps may be discharged or attempered, by setting stronger poisons, or purgatives, by them.

492. It is reported, that the shrub called *Our Ladies Seal* (which is a kind of briony) and coleworts, set near together, one or both will die. The cause is, for that they be both great depredators of the earth, and one of them starveth the other. The like is said of reed and a brake; both which are succulent; and therefore the one deceiveth the other. And the like of hemlock and rue; both which draw strong juices.

493. Some of the ancients, and likewise divers of the modern writers that have laboured in natural magic, have noted a sympathy between the sun, moon, and some principal stars, and certain herbs and plants.[1] And so they have denominated some herbs *solar*, and some *lunar;* and such like toys put into great words. It is manifest that there are some flowers that have respect to the sun; in two kinds; the one by opening and shutting, and the other by bowing and inclining the head. For marygolds, tulippa's, pimpernel, and indeed most flowers, do open or spread their leaves abroad when the sun shineth serene and fair: and again (in some part) close them or gather them inward, either towards night, or when the sky is overcast. Of this there needeth no such solemn reason to be assigned, as to say that they rejoice at the presence of the sun, and mourn at the absence thereof. For it is nothing else but a little loading of the leaves and swelling them at the bottom with the moisture of the air; whereas the dry air doth extend them. And they make it a piece of the wonder, that garden claver[2] will hide the stalk when the sun sheweth bright; which is nothing but a full expansion of the leaves. For the bowing and inclining the head, it is found in the great flower of the sun, in marygolds, wart-wort, mallow flowers, and others. The cause is somewhat more obscure than the former; but I take it to be no other, but that the part against which the sun beateth waxeth more faint and flaccid in the stalk, and thereby less able to support the flower.

494. What a little moisture will do in vegetables, even though they be dead and severed from the earth, appeareth well in the experiment of jugglers. They take the beard of

[1] See Porta's Phytognomica, i. 18.

[2] So in the original: "now universally written *clover* (says Johnson in voc.) though not so properly." — *J. S.*

an oat; which (if you mark it well) is wreathed at the bottom, and one smooth entire straw at the top. They take only the part that is wreathed, and cut off the other, leaving the beard half the breadth of a finger in length. Then they make a little cross of a quill, long-ways of that part of the quill which hath the pith; and cross ways of that piece of the quill without pith; the whole cross being the breadth of a finger high. Then they prick the bottom where the pith is, and thereinto they put the oaten-beard, leaving half of it sticking forth of the quill: then they take a little white box of wood, to deceive men, as if somewhat in the box did work the feat; in which, with a pin, they make a little hole, enough to take the beard, but not to let the cross sink down, but to stick. Then, likewise by way of imposture, they make a question; as, Who is the fairest woman in the company? or, Who hath a glove or card? and cause another to name divers persons; and upon every naming they stick the cross in the box, having first put it towards their mouth, as if they charmed it; and the cross stirreth not; but when they come to the person that they would take, as they hold the cross to their mouth, they touch the beard with the tip of their tongue and wet it; and so stick the cross in the box; and then you shall see it turn finely and softly three or four turns; which is caused by the untwining of the beard by the moisture. You may see it more evidently, if you stick the cross between your fingers instead of the box; and therefore you may see that this motion, which is effected by so little wet, is stronger than the closing or bending of the head of a marygold.

495. It is reported by some that the herb called *rosa solis*[1] (whereof they make strong waters) will at the noon-day, when the sun shineth hot and bright, have a great dew upon it; and therefore that the right name is *ros solis;* which they impute to a delight and sympathy that it hath with the sun. Men favour wonders. It were good first to be sure that the dew that is found upon it be not the dew of the morning preserved, when the dew of other herbs is breathed away; for it hath a smooth and thick leaf, that doth not discharge the dew so soon as other herbs that are more spungy and porous. And it may be purslane, or some other herb, doth the like, and is not marked. But if it be so that it hath more dew at noon than

[1] Drosera rotundifolia. The English name is Sundew.

in the morning, then sure it seemeth to be an exudation of the herb itself; as plums sweat when they are set into the oven: for you will not (I hope) think that it is like Gideon's fleece of wool, that the dew should fall upon that and no where else.

496. It is certain, that the honey-dews are found more upon oak-leaves than upon ash, or beech, or the like: but whether any cause be from the leaf itself to concoct the dew, or whether it be only that the leaf is close and smooth, (and therefore drinketh not in the dew, but preserveth it,) may be doubted. It would be well inquired, whether manna, the drug, doth fall upon certain herbs or leaves only. Flowers that have deep sockets do gather in the bottom a kind of honey, as honey-suckles, (both the woodbine and the trefoil,) lilies, and the like. And in them certainly the flower beareth part with the dew.

497. The experience is, that the froth which they call wood-seare (being like a kind of spittle) is found but upon certain herbs, and those hot ones; as lavender, lavender-cotton, sage, hyssop, &c. Of the cause of this inquire further; for it seemeth a secret. There falleth also mildew upon corn, and smutteth it; but it may be that the same falleth also upon other herbs, and is not observed.

498. It were good trial were made, whether the great consent between plants and water, which is a principal nourishment of them, will make an attraction at[1] distance, and not at touch only. Therefore take a vessel, and in the middle of it make a false bottom of coarse canvas: fill it with earth above the canvas, and let not the earth be watered; then sow some good seeds in that earth; but under the canvas, some half a foot in the bottom of the vessel, lay a great spunge thoroughly wet in water; and let it lie so some ten days; and see whether the seeds will sprout, and the earth become more moist, and the spunge more dry. The experiment formerly mentioned of the cucumber creeping to the pot of water, is far stranger than this.

Experiments in consort touching the making herbs and fruits medicinable.

499. The altering of the scent, colour, or taste of fruit, by infusing, mixing, or letting into the bark or root of the tree, herb, or flower, any coloured, aromatical, or medicinal sub-

[1] *Or* in the original. — *J. S.*

stance, are but fancies. The cause is, for that those things have passed their period, and nourish not. And all alteration of vegetables in those qualities must be by somewhat that is apt to go into the nourishment of the plant. But this is true, that where kine feed upon wild garlic, their milk tasteth plainly of the garlic; and the flesh of muttons is better tasted where the sheep feed upon wild thyme, and other wholesome herbs. Galen also speaketh of the curing of the *scirrus* of the liver, by milk of a cow that feedeth but upon certain herbs[1]; and honey in Spain smelleth (apparently) of the rosemary, or orange, from whence the bee gathereth it: and there is an old tradition of a maiden that was fed with *napellus* (which is counted the strongest poison of all vegetables) which with use did not hurt the maid, but poisoned some that had carnal company with her.[2] So it is observed by some, that there is a virtuous bezoar, and another without virtue, which appear to the show alike: but the virtuous is taken from the beast that feedeth upon the mountains, where there are theriacal herbs, and that without virtue, from those that feed in the vallies where no such herbs are. Thus far I am of opinion: that as steeped wines and beers are very medicinal; and likewise bread tempered with divers powders; so of meat also (as flesh, fish, milk, and eggs), that they may be made of great use for medicine and diet, if the beasts, fowl, or fish, be fed with a special kind of food fit for the disease. It were a dangerous thing also for secret empoisonments. But whether it may be applied unto plants and herbs, I doubt more; because the nourishment of them is a more common juice; which is hardly capable of any special quality, until the plant do assimilate it.

500. But lest our incredulity may prejudice any profitable operations in this kind, (especially since many of the ancients have set them down,) we think good briefly to propound the four means which they have devised of making plants medicinable.[3] The first is by slitting of the root, and infusing into it the medicine; as hellebore, opium, scammony, treacle, &c., and

[1] Galen in several places speaks of the medicinal qualities which milk may derive from the herbs on which the cow has fed, but I have not found the passage to which Bacon appears to refer.

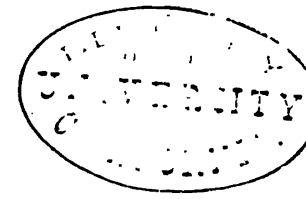
[2] See for this story Mercurialis "De venenis et morbis venenosis;" who refers to Avicenna "De viribus cordis, l.10." It occurs in the *Gesta Romanorum*; and Warton in his note refers for it to the 28th chapter of the *Secreta Secretorum*, a treatise ascribed in the middle ages to Aristotle.

[3] All these methods are mentioned by Porta, *Nat. Mag.* iii. 20.

then binding it up again. This seemeth to me the least probable; because the root draweth immediately from the earth; and so the nourishment is the more common and less qualified: and besides, it is a long time in going up ere it come to the fruit. The second way is, to perforate the body of the tree, and there to infuse the medicine; which is somewhat better: for if any virtue be received from the medicine, it hath the less way, and the less time, to go up. The third is, the steeping of the seed or kernel in some liquor wherein the medicine is infused: which I have little opinion of, because the seed (I doubt) will not draw the parts of the matter which have the propriety: but it will be far the more likely if you mingle the medicine with dung; for that the seed naturally drawing the moisture of the dung, may call in withal some of the propriety. The fourth is, the watering of the plant oft with an infusion of the medicine. This, in one respect, may have more force than the rest; because the medication is oft renewed; whereas the rest are applied but at one time; and therefore the virtue may the sooner vanish. But still I doubt that the root is somewhat too stubborn to receive those fine impressions; and besides (as I have said before) they have a great hill to go up. I judge therefore the likeliest way to be the perforation of the body of the tree in several places, one above the other; and the filling of the holes with dung mingled with the medicine; and the watering of those lumps of dung with squirts of an infusion of the medicine in dunged water, once in three or four days.

NATURAL HISTORY.

CENTURY VI.



Experiments in consort touching curiosities about fruits and plants.

OUR experiments we take care to be (as we have often said) either *experimenta fructifera* or *lucifera*; either of use or of discovery: for we hate impostures, and despise curiosities. Yet because we must apply ourselves somewhat to others, we will set down some curiosities touching plants.

501. It is a curiosity to have several fruits upon one tree [1]; and the more, when some of them come early, and some come late; so that you may have upon the same tree ripe fruits all summer. This is easily done by grafting of several scions upon several boughs of a stock, in a good ground, plentifully fed. So you may have all kinds of cherries, and all kinds of plums, and peaches, and apricots, upon one tree; but I conceive the diversity of fruits must be such as will graft upon the same stock. And therefore I doubt whether you can have apples, or pears, or oranges, upon the same stock upon which you graft plums.

502. It is a curiosity to have fruits of divers shapes and figures.[2] This is easily performed, by moulding them when the fruit is young, with moulds of earth or wood. So you may have cucumbers, &c., as long as a cane; or as round as a sphere; or formed like a cross. You may have also apples in the form of pears or lemons. You may have also fruit in more accurate

[1] Porta, Nat. Mag. iii. 19.

[2] See Porta, iii. 18.; from whom the substance of this and the next two paragraphs is taken.

figures, as we said of men, beasts, or birds, according as you make the moulds. Wherein you must understand, that you make the mould big enough to contain the whole fruit when it is grown to the greatest: for else you will choke the spreading of the fruit; which otherwise would spread itself, and fill the concave, and so be turned into the shape desired; as it is in mould-works of liquid things. Some doubt may be conceived, that the keeping of the sun from the fruit may hurt it: but there is ordinary experience of fruit that groweth covered. *Quære* also, whether some small holes may not be made in the wood to let in the sun. And note, that it were best to make the moulds partible, glued or cemented together, that you may open them when you take out the fruit.

503. It is a curiosity to have inscriptions or engravings in fruit or trees. This is easily performed, by writing with a needle, or bodkin, or knife, or the like, when the fruit or trees are young; for as they grow, so the letters will grow more large and graphical.

Tenerisque meos incidere amores
Arboribus; crescent illæ, crescetis amores.[1]

504. You may have trees apparelled with flowers or herbs, by boring holes in the bodies of them, and putting into them earth holpen with muck, and setting seeds, or slips, of violets, strawberries, wild thyme, camomile, and such like, in the earth. Wherein they do but grow in the tree as they do in pots; though (perhaps) with some feeding from the trees. It would be tried also with shoots of vines, and roots of red roses; for it may be they being of a more ligneous nature, will incorporate with the tree itself.

505. It is an ordinary curiosity to form trees and shrubs (as rosemary, juniper, and the like,) into sundry shapes; which is done by moulding them within, and cutting them without. But they are but lame things, being too small to keep figure. Great castles made of trees upon frames of timber, with turrets and arches, were anciently matters of magnificence.

506. Amongst curiosities I shall place coloration, though it be somewhat better; for beauty in flowers is their pre-eminence. It is observed by some, that gilly-flowers, sweet-williams, violets, that are coloured, if they be neglected, and

[1] Ecl. x. 53.

neither watered, nor new moulded, nor transplanted, will turn white.[1] And it is probable that the white with much culture may turn coloured. For this is certain, that the white colour cometh of scarcity of nourishment; except in flowers that are only white, and admit no other colours.

507. It is good therefore to see what natures do accompany what colours; for by that you shall have light how to induce colours, by producing those natures. Whites are more inodorate (for the most part) than flowers of the same kind coloured; as is found in single white violets, white roses, white gilly-flowers, white stock-gilly-flowers, &c. We find also that blossoms of trees, that are white, are commonly inodorate; as cherries, pears, plums; whereas those of apples, crabs, almonds, and peaches, are blushy, and smell sweet. The cause is, for that the substance that maketh the flower is of the thinnest and finest of the plant; which also maketh flowers to be of so dainty colours. And if it be too sparing and thin, it attaineth no strength of odour; except it be in such plants as are very succulent; whereby they need rather to be scanted in their nourishment than replenished, to have them sweet. As we see in white satyrion, which is of a dainty smell; and in bean-flowers, &c. And again, if the plant be of nature to put forth white flowers only, and those not thin or dry, they are commonly of rank and fulsome smell; as may-flowers, and white lilies.

508. Contrariwise, in berries the white is commonly more delicate and sweet in taste than the coloured; as we see in white grapes, in white rasps, in white strawberries, in white currants, &c. The cause is, for that the coloured are more juiced, and coarser juiced; and therefore not so well and equally concocted; but the white are better proportioned to the digestion of the plant.

509. But in fruits the white commonly is meaner; as in pear-plums, damascenes, &c. And the choicest plums are black. The mulberry (which though they call it a berry, is a fruit,) is better the black than the white. The harvest white-plum is a base plum; and the verdoccio, and white date-plum, are no very good plums. The cause is, for that they are all overwatery; whereas an higher concoction is required for sweetness, or pleasure of taste; and therefore all your dainty plums

[1] Porta, Nat. Mag. iii. 15., on the authority of Theophrastus.

are a little dry, and come from the stone; as the muscle-plum, the damascene-plum, the peach, the apricot, &c. Yet some fruits, which grow not to be black, are of the nature of berries, sweetest such as are paler; as the cœur-cherry, which inclineth more to white, is sweeter than the red; but the egriot is more sour.

510. Take gilly-flower seed, of one kind of gilly-flower, (as of the clove-gilly-flower, which is the most common,) and sow it; and there will come up gilly-flowers, some of one colour, and some of another, casually, as the seed meeteth with nourishment in the earth; so that the gardeners find that they may have two or three roots amongst an hundred that are rare and of great price; as purple, carnation of several stripes: the cause is (no doubt) that in earth, though it be contiguous and in one bed, there are very several juices; and as the seed doth casually meet with them, so it cometh forth. And it is noted especially that those which do come up purple, do always come up single: the juice, as it seemeth, not being able to suffice a succulent colour and a double leaf. This experiment of several colours coming up from one seed, would be tried also in larks-foot, monks-hood, poppy, and holly-oak.

511. Few fruits are coloured red within: the queen-apple is; and another apple, called the rose-apple: mulberries likewise; and grapes, though most toward the skin. There is a peach also that hath a circle of red towards the stone: and the egriot cherry is somewhat red within; but no pear, nor warden, nor plum, nor apricot, although they have many times red sides, are coloured red within. The cause may be inquired.

512. The general colour of plants is green, which is a colour that no flower is of. There is a greenish primrose, but it is pale, and scarce a green. The leaves of some trees turn a little murry or reddish, and they be commonly young leaves that do so; as it is in oaks, and vines, and hazle. Leaves rot into a yellow, and some hollies have part of their leaves yellow, that are, to all seeming, as fresh and shining as the green. I suppose also, that yellow is a less succulent colour than green, and a degree nearer white. For it hath been noted that those yellow leaves of holly stand ever towards the north or north-east. Some roots are yellow, as carrots; and some plants blood- red, stalk and leaf and all; as amaranthus. Some herb incline to purple and red; as a kind of sage doth, and a kind

of mint, and rosa solis, &c. And some have white leaves, as another kind of sage, and another kind of mint; but azure and a fair purple are never found in leaves. This sheweth that flowers are made of a refined juice of the earth, and so are fruits; but leaves of a more coarse and common.

513. It is a curiosity also to make flowers double; which is effected by often removing them into new earth: as, on the contrary part, double flowers, by neglecting and not removing, prove single. And the way to do it speedily, is to sow or set seeds or slips of flowers; and as soon as they come up, to remove them into new ground that is good. Inquire also, whether inoculating of flowers, (as stock-gilly-flowers, roses, musk-roses, &c.,) doth not make them double. There is a cherry-tree that hath double blossoms; but that tree beareth no fruit: and it may be, that the same means which, applied to the tree, doth extremely accelerate the sap to rise and break forth, would make the tree spend itself in flowers, and those to become double: which were a great pleasure to see, especially in apple-trees, peach-trees, and almond-trees, that have blossoms blush-coloured.

514. The making of fruits without core or stone, is likewise a curiosity; and somewhat better; because whatsoever maketh them so, is like to make them more tender and delicate. If a scion or shoot, fit to be set in the ground, have the pith finely taken forth (and not altogether, but some of it left, the better to save the life), it will bear a fruit with little or no core or stone. And the like is said to be of dividing a quick-tree down to the ground, and taking out the pith, and then binding it up again.[1]

515. It is reported also, that a citron grafted upon a quince will have small or no seeds; and it is very probable that any sour fruit grafted upon a stock that beareth a sweeter fruit, may both make the fruit sweeter, and more void of the harsh matter of kernels or seeds.

516. It is reported, that not only the taking out of the pith, but the stopping of the juice of the pith from rising in the midst, and turning it to rise on the outside, will make the fruit without core or stone; as if you should bore a tree clean through, and put a wedge in. It is true, there is some affinity

[1] This and the succeeding paragraphs, to 517. inclusive, are from Porta, *Nat. Mag.* lib. 12.

between the pith and the kernel, because they are both of a harsh substance, and both placed in the midst.

517. It is reported, that trees watered perpetually with warm water, will make a fruit with little or no core or stone. And the rule is general, that whatsoever will make a wild tree a garden tree, will make a garden tree to have less core or stone.

Experiments in consort touching the degenerating of plants; and of the transmutation of them one into another.[1]

518. The rule is certain, that plants for want of culture degenerate to be baser in the same kind; and sometimes so far as to change into another kind. 1. The standing long, and not being removed, maketh them degenerate. 2. Drought, unless the earth of itself be moist, doth the like. 3. So doth removing into worse earth, or forbearing to compost the earth; as we see that water-mint turneth into field-mint, and the colewort into rape, by neglect, &c.

519. Whatsoever fruit useth to be set upon a root or a slip, if it be sown will degenerate. Grapes sown; figs, almonds, pomegranate kernels sown; make the fruits degenerate and become wild. And again, most of those fruits that use to be grafted, if they be set of kernels or stones, degenerate. It is true that peaches, (as hath been touched before,) do better upon stones set than upon grafting; and the rule of exception should seem to be this: that whatsoever plant requireth much moisture, prospereth better upon the stone or kernel, than upon the graft. For the stock, though it giveth a finer nourishment, yet it giveth a scanter, than the earth at large.

520. Seeds, if they be very old, and yet have strength enough to bring forth a plant, make the plant degenerate. And therefore skilful gardeners make trial of the seeds before they buy them, whether they be good or no, by putting them in water gently boiled; and if they be good, they will sprout within half an hour.

521. It is strange which is reported, that basil too much exposed to the sun doth turn into wild thyme[2]; although those two herbs seem to have small affinity; but basil is almost the only hot herb that hath fat and succulent leaves; which oili-

[1] See Porta, Nat. Mag. iii. 2.

[2] The original authority for this is Palladius, *Apr.* iii.

ness if it be drawn forth by the sun, it is like it will make a very great change.

522. There is an old tradition, that boughs of oak put into the earth will put forth wild vines[1]: which if it be true, no doubt it is not the oak that turneth into a vine, but the oak-bough putrefying qualifieth the earth to put forth a vine of itself.

523. It is not impossible, and I have heard it verified, that upon cutting down of an old timber tree, the stub hath put out sometimes a tree of another kind; as that beech hath put forth birch; which, if it be true, the cause may be, for that the old stub is too scant of juice to put forth the former tree; and therefore putteth forth a tree of smaller kind, that needeth less nourishment.

524. There is an opinion in the country, that if the same ground be oft sown with the grain that grew upon it, it will in the end grow to be of a baser kind.

525. It is certain, that in very sterile years corn sown will grow to another kind.

> Grandia sæpe quibus mandavimus hordea sulcis,
> Infelix lolium et steriles dominantur avenæ.[2]

And generally it is a rule, that plants that are brought forth by culture, as corn, will sooner change into other species than those that come of themselves; for that culture giveth but an adventitious nature, which is more easily put off.

This work of the transmutation of plants one into another, is *inter magnalia naturæ:* for the transmutation of species is, in the vulgar philosophy, pronounced impossible; and certainly it is a thing of difficulty, and requireth deep search into nature; but seeing there appear some manifest instances of it, the opinion of impossibility is to be rejected, and the means thereof to be found out. We see that in living creatures that come of putrefaction, there is much transmutation of one into another; as caterpillars turn into flies, &c. And it should seem probable that whatsoever creature, having life, is generated without seed, that creature will change out of one species into another. For it is the seed, and the nature of it, which locketh and boundeth

[1] Porta gives this on the authority of Albertus Magnus.
[2] Virg. Georg. i. 154.

in the creature, that it doth not expatiate. So as we may well conclude, that seeing the earth of itself doth put forth plants without seed, therefore plants may well have a transmigration of species. Wherefore, wanting instances which do occur, we shall give directions of the most likely trials; and generally, we would not have those that read this our work of *Sylva Sylvarum* account it strange, or think that it is an over-haste, that we have set down particulars untried; for contrariwise, in our own estimation, we account such particulars more worthy than those that are already tried and known; for these latter must be taken as you find them; but the other do level point-blank at the inventing of causes and axioms.

526. First therefore, you must make account, that if you will have one plant change into another, you must have the nourishment over-rule the seed; and therefore you are to practise it by nourishments as contrary as may be to the nature of the herb; so nevertheless as the herb may grow; and likewise with seeds that are of the weakest sort, and have least vigour. You shall do well, therefore, to take marsh-herbs, and plant them on tops of hills and champaigns; and such plants as require much moisture, upon sandy and very dry grounds. As for example, marsh-mallows and sedge, upon hills; cucumber, and lettuce-seeds, and coleworts, upon a sandy plot; so contrariwise, plant bushes, heath, ling, and brakes, upon a wet or marsh ground. This I conceive also, that all esculent and garden herbs, set upon the tops of hills, will prove more medicinal, though less esculent than they were before. And it may be likewise, some wild herbs you may make sallet herbs. This is the first rule for transmutation of plants.

527. The second rule shall be, to bury some few seeds of the herb you would change amongst other seeds; and then you shall see whether the juice of those other seeds do not so qualify the earth, as it will alter the seed whereupon you work. As for example, put parsley-seed amongst onion-seed, or lettuce-seed amongst parsley-seed, or basil-seed amongst thyme-seed; and see the change of taste or otherwise. But you shall do well to put the seed you would change into a little linen cloth, that it mingle not with the foreign seed.

528 The third rule shall be, the making of some medley or

mixture of earth with some other plants bruised or shaved, either in leaf or root; as for example, make earth with a mixture of colewort leaves stamped, and set in it artichokes or parsnips: so take earth made with marjoram, or origanum, or wild thyme, bruised or stamped, and set in it fennel-seed, &c. In which operation the process of nature still will be (as I conceive), not that the herb you work upon should draw the juice of the foreign herb (for that opinion we have formerly rejected), but there will be a new confection of mould, which perhaps will alter the seed, and yet not to the kind of the former herb.

529. The fourth rule shall be, to mark what herbs some earths do put forth of themselves; and to take that earth and to pot it, or to vessel it; and in that to set the seed you would change: as for example, take from under walls or the like where nettles put forth in abundance, the earth which you shall there find, without any string or root of the nettles; and pot that earth, and set in it stock-gilly-flowers, or wall-flowers, &c.; or sow in the seeds of them; and see what the event will be. Or take earth that you have prepared to put forth mushrooms of itself, (whereof you shall find some instances following,) and sow in it purslane-seed, or lettuce-seed; for in these experiments, it is likely enough that the earth being accustomed to send forth one kind of nourishment, will alter the new seed.

530. The fifth rule shall be, to make the herb grow contrary to his nature; as to make ground-herbs rise in height: as for example, carry camomile, or wild thyme, or the green strawberry, upon sticks, as you do hops upon poles; and see what the event will be.

531. The sixth rule shall be, to make plants grow out of the sun or open air; for that is a great mutation in nature, and may induce a change in the seed; as barrel up earth, and sow some seed in it, and put it in the bottom of a pond, or put it in some great hollow tree: try also the sowing of seeds in the bottoms of caves; and pots with seeds sown, hanged up in wells some distance from the water; and see what the event will be.

Experiments in consort touching the procerity and lowness and artificial dwarfing of trees.

532. It is certain that timber-trees in coppice-woods grow more upright, and more free from under-boughs, than those

that stand in the fields: the cause whereof is, for that plants have a natural motion to get to the sun; and besides, they are not glutted with too much nourishment; for that the coppice shareth with them; and repletion ever hindereth stature: lastly, they are kept warm; and that ever in plants helpeth mounting.

533. Trees that are of themselves full of heat, (which heat appeareth by their inflammable gums,) as firs and pines, mount of themselves in height without side-boughs, till they come towards the top. The cause is partly heat, and partly tenuity of juice, both which send the sap upwards. As for juniper, it is but a shrub, and groweth not big enough in body to maintain a tall tree.

534. It is reported that a good strong canvas, spread over a tree grafted low, soon after it putteth forth, will dwarf it, and make it spread. The cause is plain; for that all things that grow, will grow as they find room.

535. Trees are generally set of roots or kernels; but if you set them of slips, (as of some trees you may, by name the mulberry,) some of the slips will take; and those that take (as is reported) will be dwarf trees. The cause is, for that a slip draweth nourishment more weakly than either a root or kernel.

536. All plants that put forth their sap hastily, have their bodies not proportionable to their length; and therefore they are winders and creepers; as ivy, briony, hops, woodbine; whereas dwarfing requireth a slow putting forth, and less vigour of mounting.

Experiments in consort touching the rudiments of plants; and of the excrescences of plants, or super-plants.

The Scripture saith that Salomon wrote a Natural History, from the cedar of Libanus, to the moss growing upon the wall; for so the best translations have it. And it is true that moss is but the rudiment of a plant; and (as it were) the mould of earth or bark.

537. Moss groweth chiefly upon ridges of houses tiled or thatched, and upon the crests of walls; and that moss is of a lightsome and pleasant green. The growing upon slopes is caused, for that moss, as on the one side it cometh of moisture and water, so on the other side the water must but slide, and not stand or pool. And the growing upon tiles, or walls, &c.,

is caused, for that those dried earths, having not moisture sufficient to put forth a plant, do practise germination by putting forth moss; though when by age, or otherwise, they grow to relent and resolve, they sometimes put forth plants; as wall-flowers. And almost all moss hath here and there little stalks, besides the low thrum.

538. Moss groweth upon alleys, especially such as lie cold and upon the north; as in divers terraces: and again, if they be much trodden; or if they were at the first gravelled; for wheresoever plants are kept down, the earth putteth forth moss.

539. Old ground, that hath been long unbroken up, gathereth moss; and therefore husbandmen use to cure their pasture grounds when they grow to moss, by tilling them for a year or two: which also dependeth upon the same cause; for that the more sparing and starving juice of the earth, insufficient for plants, doth breed moss.

540. Old trees are more mossy far than young; for that the sap is not so frank as to rise all to the boughs, but tireth by the way, and putteth out moss.

541. Fountains have moss growing upon the ground about them;

Muscosi fontes;[1]

The cause is, for that the fountains drain the water from the ground adjacent, and leave but sufficient moisture to breed moss: and besides, the coldness of the water conduceth to the same.

542. The moss of trees is a kind of hair; for it is the juice of the tree that is excerned, and doth not assimilate. And upon great trees the moss gathereth a figure, like a leaf.

543. The moister sort of trees yield little moss; as we see in asps, poplars, willows, beeches, &c.; which is partly caused for the reason that hath been given, of the frank putting up of the sap into the boughs; and partly for that the barks of those trees are more close and smooth than those of oaks and ashes; whereby the moss can the hardlier issue out.

544. In clay-grounds all fruit-trees grow full of moss, both upon body and boughs; which is caused partly by the coldness of the ground, whereby the plants nourish less; and partly by

[1] Virg. Ecl. vii. 45.

the toughness of the earth, whereby the sap is shut in, and cannot get up to spread so frankly as it should do.

545. We have said heretofore, that if trees be hide-bound, they wax less fruitful, and gather moss; and that they are holpen by hacking, &c. And, therefore, by the reason of contraries, if trees be bound in with cords or some outward bands, they will put forth more moss: which, I think, happeneth to trees that stand bleak, and upon the cold winds. It would also be tried, whether, if you cover a tree somewhat thick upon the top after his polling, it will not gather more moss. I think also the watering of trees with cold fountain-water, will make them grow full of moss.

546. There is a moss the perfumers have, which cometh out of apple trees, that hath an excellent scent. *Quære* particularly for the manner of the growth, and the nature of it. And for this experiment's sake, being a thing of price, I have set down the last experiments, how to multiply and call on mosses.

Next unto moss, I will speak of mushrooms; which are likewise an imperfect plant. The mushrooms have two strange properties; the one, that they yield so delicious a meat; the other, that they come up so hastily, as in a night; and yet they are unsown. And therefore such as are upstarts in state, they call in reproach mushrooms. It must needs be therefore, that they be made of much moisture; and that moisture fat, gross, and yet somewhat concocted. And indeed, we find that mushrooms cause the accident, which we call *incubus* or the mare, in the stomach. And therefore the surfeit of them may suffocate and empoison. And this sheweth that they are windy; and that windiness is gross and swelling, not sharp or griping. And upon the same reason mushrooms are a venereous meat.

547. It is reported, that the bark of white or red poplar, (which are of the moistest of trees), cut small, and cast into furrows well dunged, will cause the ground to put forth mushrooms at all seasons of the year, fit to be eaten. Some add to the mixture leaven of bread, resolved in water.[1]

[1] Porta, Nat. Mag. iii. 1. From the same chapter are taken 548. and 550. and probably, though with some discrepancy, 549. also.

548. It is reported that if a hilly field, where the stubble is standing, be set on fire in the showery season, it will put forth great store of mushrooms.

549. It is reported that hartshorn, shaven or in small pieces, mixed with dung and watered, putteth up mushrooms. And we know that hartshorn is of a fat and clammy substance: and it may be ox-horn would do the like.

550. It hath been reported, though it be scarce credible that ivy hath grown out of a stag's horn [1]; which they suppose did rather come from a confrication of the horn upon the ivy, than from the horn itself. There is not known any substance but earth, and the procedures of earth, (as tile, stone, &c.) that yieldeth any moss or herby substance. There may be trial made of some seeds, as that of fennel-seed, mustard-seed, and rape-seed, put into some little holes made in the horns of stags or oxen, to see if they will grow.

551. There is also another unperfect plant, that (in shew) is like a great mushroom; and it is sometimes as broad as one's hat; which they call a toad's-stool: but it is not esculent; and it groweth (commonly) by a dead stub of a tree; and likewise about the roots of rotten trees: and therefore seemeth to take his juice from wood putrefied. Which sheweth, by the way, that wood putrefied yieldeth a frank moisture.

552. There is a cake that groweth upon the side of a dead tree, that hath gotten no name, but it is large, and of a chesnut colour, and hard and pithy; whereby it should seem, that even dead trees forget not their putting forth; no more than the carcasses of men's bodies, that put forth hair and nails for a time.

553. There is a cod, or bag, that groweth commonly in the fields; that at first is hard like a tennis-ball, and white; and after groweth of a mushroom colour, and full of light dust upon the breaking; and is thought to be dangerous for the eyes if the powder get into them; and to be good for kibes. Belike it hath a corrosive and fretting nature.

554. There is an herb called Jew's ear, that groweth upon the roots and lower parts of the bodies of trees; especially of elders, and sometimes ashes. It hath a strange property; for in warm water it swelleth, and openeth extremely. It is not green, but of a dusky brown colour. And it is used for

[1] Arist. Mirab. 5.

squinancies and inflammations in the throat; whereby it seemeth to have a mollifying and lenifying virtue.

555. There is a kind of spungy excrescence, which groweth chiefly upon the roots of the laser-tree; and sometimes upon cedar and other trees. It is very white, and light, and friable; which we call agaric. It is famous in physic for the purging of tough phlegm. And it is also an excellent opener for the liver; but offensive to the stomach: and in taste, it is at the first sweet, and after bitter.

556. We find no super-plant that is a formed plant, but misseltoe.[1] They have an idle tradition that there is a bird called a missel-bird, that feedeth upon a seed, which many times she cannot digest, and so expelleth it whole with her excrement: which falling upon the bough of a tree that hath some rift, putteth forth misseltoe. But this is a fable: for it is not probable that birds should feed upon that they cannot digest. But allow that, yet it cannot be for other reasons: for first, it is found but upon certain trees; and those trees bear no such fruit as may allure that bird to sit and feed upon them. It may be that bird feedeth upon the misseltoe-berries, and so is often found there; which may have given occasion to the tale. But that which maketh an end of the question is, that misseltoe hath been found to put forth under the boughs, and not only above the boughs; so it cannot be anything that falleth upon the bough. Misseltoe groweth chiefly upon crab-trees, apple-trees, sometimes upon hazles; and rarely upon oaks; the misseltoe whereof is counted very medicinal. It is ever green, winter and summer; and beareth a white glistering berry: and it is a plant utterly differing from the plant upon which it groweth. Two things therefore may be certainly set down: first, that superfœtation must be by abundance of sap in the bough that putteth it forth: secondly, that that sap must be such as the tree doth excern, and cannot assimilate; for else it would go into a bough; and besides, it seemeth to be more fat and unctuous than the ordinary sap of the tree; both

[1] We are now acquainted with many plants besides the misseltoe which are strictly parasitic, and yet what Bacon here calls perfect—that is, apparently, phanerogamous. I am not aware whether Decandolle's experiments with regard to the influence of the leaves of the misseltoe on the ascent of sap in the parent branch have been repeated, or extended to any other parasite.

The tradition that the misseltoe was condemned to become a parasite in consequence of having furnished the wood of the True Cross, is one of the most remarkable of the superstitions of which it is the subject.

by the berry, which is clammy; and by that it continueth green winter and summer, which the tree doth not.

557. This experiment of misseltoe may give light to other practices. Therefore trial would be made by ripping of the bough of a crab-tree in the bark, and watering of the wound every day with warm water dunged, to see if it would bring forth misseltoe, or any such like thing. But it were yet more likely to try it with some other watering or anointing, that were not so natural to the tree as water is; as oil, or barm of drink, &c.; so they be such things as kill not the bough.

558. It were good to try what plants would put forth, if they be forbidden to put forth their natural boughs. Poll therefore a tree, and cover it some thickness with clay on the top, and see what it will put forth. I suppose it will put forth roots; for so will a scion, being turned down into clay: therefore in this experiment also, the tree would be closed with somewhat that is not so natural to the plant as clay is. Try it with leather, or cloth, or painting, so it be not hurtful to the tree. And it is certain that a brake hath been known to grow out of a pollard.

559. A man may count the prickles of trees to be a kind of excrescence; for they will never be boughs, nor bear leaves. The plants that have prickles are, thorns, black and white, briar, rose, lemon-trees, crab-trees, gooseberry, berberry; these have it in the bough: the plants that have prickles in the leaf are, holly, juniper, whin-bush, thistle; nettles also have a small venomous prickle; so hath borage, but harmless. The cause must be, hasty putting forth, want of moisture, and the closeness of the bark; for the haste of the spirit to put forth, and the want of nourishment to put forth a bough, and the closeness of the bark, cause prickles in boughs; and therefore they are ever like a pyramis, for that the moisture spendeth after a little putting forth. And for prickles in leaves, they come also of putting forth more juice into the leaf than can spread in the leaf smooth; and therefore the leaves otherwise are rough, as borage and nettles are. As for the leaves of holly, they are smooth, but never plain, but as it were with folds, for the same cause.

560. There be also plants, that though they have no prickles, yet they have a kind of downy or velvet rine upon their leaves; as rose-campion, stock-gilly-flowers, colt's-foot; which down or

nap cometh of a subtile spirit, in a soft or fat substance. For it is certain that both stock-gilly-flowers and rose-campions, stamped, have been applied with success to the wrists of those that have had tertian or quartan agues; and the vapour of colt's-foot hath a sanative virtue towards the lungs; and the leaf also is healing in surgery.

561. Another kind of excrescence is an exudation of plants, joined with putrefaction; as we see in oak-apples, which are found chiefly upon the leaves of oaks; and the like upon willows: and country people have a kind of prediction, that if the oak-apple broken be full of worms, it is a sign of a pestilent year; which is a likely thing, because they grow of corruption.

562. There is also upon sweet or other briar, a fine tuft or brush of moss, of divers colours; which if you cut you shall ever find full of little white worms.

Experiments in consort touching the producing of perfect plants without seeds.

563. It is certain that earth taken out of the foundations of vaults and houses, and bottoms of wells, and then put into pots, will put forth sundry kinds of herbs[1]: but some time is required for the germination: for if it be taken but from a fathom deep, it will put forth the first year; if much deeper, not till after a year or two.

564. The nature of the plants growing out of the earth so taken up, doth follow the nature of the mould itself; as if the mould be soft and fine, it putteth forth soft herbs; as grass, plantain, and the like; if the earth be harder and coarser, it putteth forth herbs more rough, as thistles, furze[2], &c.

565. It is common experience, that where alleys are close gravelled, the earth putteth forth the first year knot-grass, and after spire-grass. The cause is, for that the hard gravel or pebble at the first laying will not suffer the grass to come forth upright, but turneth it to find his way where it can; but after that the earth is somewhat loosened at the top, the ordinary grass cometh up.

566. It is reported that earth being taken out of shady and watery woods some depth, and potted, will put forth herbs of a

[1] Porta, Nat. Mag. lii. 1. The next paragraph seems to be taken from the same passage.

[2] *Firres* in the original.—*J. S.*

fat and juicy substance; as penny-wort, purslane, houseleek, penny-royal, &c.[1]

567. The water also doth send forth plants that have no roots fixed in the bottom; but they are less perfect plants, being almost but leaves, and those small ones; such is that we call duck-weed; which hath a leaf no bigger than a thyme-leaf, but of a fresher green, and putteth forth a little string into the water far from the bottom. As for the water-lily, it hath a root in the ground; and so have a number of other herbs that grow in ponds.

568. It is reported by some of the ancients, and some modern testimony likewise, that there be some plants that grow upon the top of the sea; being supposed to grow of some concretion of slime from the water, where the sun beateth hot, and where the sea stirreth little.[2] As for the alga marina (sea-weed) and eryngium (sea-thistle), both have roots; but the sea-weed under the water, the sea-thistle but upon the shore.

569. The ancients have noted, that there are some herbs that grow out of snow, laid up close together and putrefied; and that they are all bitter; and they name one specially, *flomus*, which we call moth-mullein.[3] It is certain that worms are found in snow commonly, like earth-worms; and therefore it is not unlike, that it may likewise put forth plants.

570. The ancients have affirmed that there are some herbs that grow out of stone[4]; which may be, for that it is certain that toads have been found in the middle of a free-stone. We see also that flints, lying above ground, gather moss; and wall-flowers, and some other flowers, grow upon walls; but whether upon the main brick or stone, or whether out of the lime or chinks, is not well observed; for elders and ashes have been seen to grow out of steeples; but they manifestly grow out of clefts; insomuch as when they grow big, they will disjoin the stone. And besides, it is doubtful whether the mortar itself putteth it forth, or whether some seeds be not let fall by birds. There be likewise rock-herbs; but I suppose those are where there is some mould or earth. It hath likewise been found that great trees growing upon quarries have put down their root into the stone.

571. In some mines in Germany, as is reported, there grow

[1] Porta, ubi supra.
[2] See the treatise *De Plantis*, ascribed to Aristotle, ii. 4.
[3] Ib. ii. 3.
[4] Ib. ii. 5.

in the bottom vegetables; and the work-folks use to say they have magical virtue, and will not suffer men to gather them.

572. The sea-sands seldom bear plants. Whereof the cause is yielded by some of the ancients, for that the sun exhaleth the moisture before it can incorporate with the earth and yield a nourishment for the plant.[1] And it is affirmed also that sand hath always his root in clay; and that there be no veins of sand any great depth within the earth.

573. It is certain that some plants put forth for a time of their own store, without any nourishment from earth, water, stone, &c. Of which vide the experiment 29.

Experiments in consort touching foreign plants.

574. It is reported that earth that was brought out of the Indies and other remote countries for ballast for ships, cast upon some grounds in Italy, did put forth foreign herbs, to us in Europe not known; and, that which is more, that of their roots, barks, and seeds, contused together, and mingled with other earth, and well watered with warm water, there came forth herbs much like the other.[2]

575. Plants brought out of hot countries will endeavour to put forth at the same time that they usually do in their own climate; and therefore to preserve them, there is no more required than to keep them from the injury of putting back by cold. It is reported also that grain out of the hotter countries translated into the colder, will be more forward than the ordinary grain of the cold country. It is likely that this will prove better in grains than in trees; for that grains are but annual, and so the virtue of the seed is not worn out; whereas in a tree it is embased by the ground to which it is removed.

576. Many plants which grow in the hotter countries, being set in the colder, will nevertheless, even in those cold countries, being sown of seeds late in the spring, come up and abide most part of the summer; as we find it in orange and lemon seeds, &c., the seeds whereof sown in the end of April will bring forth excellent sallets, mingled with other herbs. And I doubt not but the seeds of clove-trees, and pepper-seeds, &c., if they could come hither green enough to be sown, would do the like.

[1] See the treatise *De Plantis*, ascribed to Aristotle, ii. 3.
[2] Porta, Nat. Mag. iii. 1.; but not accurately copied.

Experiment in consort touching the seasons in which plants come forth.

577. There be some flowers, blossoms, grains, and fruits, which come more early, and others which come more late in the year. The flowers that come early, with us, are, primroses, violets, anemonies, water-daffodillies, crocus vernus, and some early tulippa's. And they are all cold plants; which therefore (as it should seem) have a quicker perception of the heat of the sun increasing than the hot herbs have; as a cold hand will sooner find a little warmth than a hot. And those that come next after are wall-flowers, cowslips, hyacinths, rosemary flowers, &c.; and after them pinks, roses, flower-de-luces, &c.; and the latest are gilly-flowers, holly-oaks, larks-foot, &c. The earliest blossoms are the blossoms of peaches, almonds, cornelians, mezerions, &c.; and they are of such trees as have much moisture, either watery or oily. And therefore crocus vernus also, being an herb that hath an oily juice, putteth forth early; for those also find the sun sooner than the drier trees. The grains are, first rye and wheat, then oats and barley, then peas and beans. For though green peas and beans be eaten sooner, yet the dry ones that are used for horse-meat, are ripe last; and it seemeth that the fatter grain cometh first. The earliest fruits are strawberries, cherries, gooseberries, currants; and after them early apples, early pears, apricots, rasps; and after them, damascenes, and most kind of plums, peaches, &c.; and the latest are apples, wardens, grapes, nuts, quinces, almonds, sloes, briar-berries, heps, medlars, services, cornelians, &c.

578. It is to be noted, that (commonly) trees that ripen latest blossom soonest; as peaches, cornelians, sloes, almonds, &c.: and it seemeth to be a work of providence that they blossom so soon; for otherwise they could not have the sun long enough to ripen.

579. There be fruits (but rarely) that come twice a year; as some pears, strawberries, &c. And it seemeth they are such as abound with nourishment; whereby, after one period, before the sun waxeth too weak they can endure another. The violet also, amongst flowers, cometh twice a year; especially the double white; and that also is a plant full of moisture. Roses

come twice, but it is not without cutting, as hath been formerly said.

580. In Muscovia, though the corn come not up till late spring, yet their harvest is as early as ours. The cause is, for that the strength of the ground is kept in with the snow; and we see with us, that if it be a long winter, it is commonly a more plentiful year: and after those kind of winters likewise, the flowers and corn, which are earlier and later, do come commonly at once, and at the same time; which troubleth the husbandman many times; for you shall have red roses and damask roses come together; and likewise the harvest of wheat and barley. But this happeneth ever, for that the earlier stayeth for the later, and not that the later cometh sooner.

581. There be divers fruit-trees in the hot countries, which have blossoms and young fruit and ripe fruit, almost all the year, succeeding one another. And it is said the orange hath the like with us for a great part of summer; and so also hath the fig. And no doubt the natural motion of plants is to have so; but that either they want juice to spend, or they meet with the cold of the winter; and therefore this circle of ripening cannot be but in succulent plants, and hot countries.

582. Some herbs are but annual, and die, root and all, once a year; as borage, lettuce, cucumbers, musk-melons, basil, tobacco, mustard-seed, and all kinds of corn: some continue many years; as hyssop, germander, lavender, fennel, &c. The cause of the dying is double; the first is, the tenderness and weakness of the seed, which maketh the period in a small time; as it is in borage, lettuce, cucumbers, corn, &c.; and therefore none of these are hot. The other cause is, for that some herbs can worse endure cold; as basil, tobacco, mustard-seed. And these have all much heat.

Experiments in consort touching the lasting of herbs and trees.

583. The lasting of plants is most in those that are largest of body; as oaks, elm, chesnut, the loat-tree, &c.; and this holdeth in trees; but in herbs it is often contrary: for borage, coleworts, pompions, which are herbs of the largest size, are of small durance; whereas hyssop, winter-savoury, germander, thyme, sage, will last long. The cause is, for that trees last according to the strength and quantity of their sap and juice; being well munited by their bark against the injuries of the air; but herbs

draw a weak juice, and have a soft stalk; and therefore those amongst them which last longest, are herbs of strong smell, and with a sticky stalk.

584. Trees that bear mast, and nuts, are commonly more lasting than those that bear fruits, especially the moister fruits; as oaks, beeches, chesnuts, walnuts, almonds, pine-trees, &c. last longer than apples, pears, plums, &c. The cause is the fatness and oiliness of the sap; which ever wasteth less than the more watery.

585. Trees that bring forth their leaves late in the year, and cast them likewise late, are more lasting than those that sprout their leaves early, or shed them betimes. The cause is, for that the late coming forth sheweth a moisture more fixed; and the other more loose and more easily resolved. And the same cause is, that wild trees last longer than garden trees; and in the same kind, those whose fruit is acid, more than those whose fruit is sweet.

586. Nothing procureth the lasting of trees, bushes, and herbs, so much as often cutting; for every cutting causeth a renovation of the juice of the plant; that it neither goeth so far, nor riseth so faintly, as when the plant is not cut; insomuch as annual plants, if you cut them seasonably, and will spare the use of them, and suffer them to come up still young, will last more years than one; as hath been partly touched; such as is lettuce, purslane, cucumber, and the like. And for great trees, we see almost all overgrown trees in churchyards, or near ancient buildings, and the like, are pollards, or dottards, and not trees at their full height.

587. Some experiment would be made, how by art to make plants more lasting than their ordinary period: as to make a stalk of wheat, &c., last a whole year. You must ever presuppose, that you handle it so as the winter killeth it not; for we speak only of prolonging the natural period. I conceive that the rule will hold, that whatsoever maketh the herb come later than at his time, will make it last longer time: it were good to try it in a stalk of wheat, &c., set in the shade, and encompassed with a case of wood, not touching the straw, to keep out open air.

As for the preservation of fruits, as well upon the tree or stalk as gathered, we shall handle it under the title of conservation of bodies.

Experiments in consort touching the several figures of plants.

588. The particular figures of plants we leave to their descriptions; but some few things in general we will observe. Trees and herbs, in the growing forth of their boughs and branches, are not figured, and keep no order. The cause is, for that the sap being restrained in the rind and bark, breaketh not forth at all, (as in the bodies of trees, and stalks of herbs,) till they begin to branch; and then when they make an eruption, they break forth casually, where they find best way, in the bark or rind. It is true, that some trees are more scattered in their boughs; as sallow-trees, warden-trees, quince-trees, medlar-trees, lemon-trees, &c. Some are more in the form of a pyramis, and come almost to todd; as the pear-tree, (which the critics will have to borrow his name of *πῦρ, fire,*) orange-trees, fir-trees, service-trees, lime-trees, &c.; and some are more spread and broad; as beeches, hornbeam, &c. The rest are more indifferent. The cause of scattering the boughs, is the hasty breaking forth of the sap; and therefore those trees rise not in a body of any height, but branch near the ground. The cause of the pyramis is the keeping in of the sap long before it branch; and the spending of it, when it beginneth to branch, by equal degrees. The spreading is caused by the carrying up of the sap plentifully without expence; and then putting it forth speedily and at once.

589. There be divers herbs, but no trees, that may be said to have some kind of order in the putting forth of their leaves; for they have joints or knuckles, as it were stops in their germination; as have gilly-flowers, pinks, fennel, corn, reeds, and canes. The cause whereof is, for that the sap ascendeth unequally, and doth (as it were) tire and stop by the way. And it seemeth they have some closeness and hardness in their stalk, which hindereth the sap from going up, until it hath gathered into a knot, and so is more urged to put forth. And therefore they are most of them hollow when the stalk is dry; as fennel-stalk, stubble, and canes.

590. Flowers have all exquisite figures; and the flower-numbers are (chiefly) five and four; as in primroses, briar-roses, single musk-roses, single pinks, and gilly-flowers, &c., which have five leaves: lilies, flower-de-luces, borage, bugloss,

&c., which have four leaves.[1] But some put forth leaves not numbered; but they are ever small ones; as marygolds, trefoil, &c. We see also, that the sockets and supporters of flowers are figured; as in the five brethren of the rose, sockets of gilly-flowers, &c. Leaves also are all figured; some round, some long; none square; and many jagged on the sides; which leaves of flowers seldom are. For I account the jagging of pinks and gilly-flowers, to be like the inequality of oak leaves, or vine leaves, or the like: but they seldom or never have any small purls.[2]

Experiments in consort touching some principal differences in plants.

591. Of plants, some few put forth their blossoms before their leaves; as almonds, peaches, cornelians, black-thorn, &c. But most put forth some leaves before their blossoms; as apples, pears, plums, cherry, white-thorn, &c. The cause is, for that those that put forth their blossoms first, have either an acute and sharp spirit, (and therefore commonly they all put forth early in the spring and ripen very late, as most of the particulars before mentioned,) or else an oily juice, which is apter to put out flowers than leaves.

592. Of plants, some are green all winter; others cast their leaves. There are green all winter, holly, ivy, box, fir, yew, cypress, juniper, bays, rosemary, &c. The cause of the holding green, is the close and compact substance of their leaves, and the pedicles of them. And the cause of that again is either the tough and viscous juice of the plant, or the strength and heat thereof. Of the first sort is holly, which is of so viscous a juice as they make birdlime of the bark of it. The stalk of ivy is tough and not fragile, as we see in other small twigs dry. Fir yieldeth pitch. Box is a fast and heavy wood, as we see it in bowls. Yew is a strong and tough wood, as we see it in bows. Of the second sort is juniper, which is a wood odorate, and maketh a hot fire. Bays is likewise a hot and aromatical wood; and so is rosemary for a shrub. As for the leaves, their density appeareth, in that either they are smooth and shining,

[1] There are several errors in this remark; the flower number of the lily, as of almost all endogenous plants, being three, and that of borage and bugloss, five.

[2] According to Mr. MacCosh's observations, the venation of the leaf corresponds to the mode of growth of the branches, the veins being given off at the same angle as the branches.

as in bays, holly, ivy, box, &c., or in that they are hard and spiry, as in the rest. And trial would be made of grafting of rosemary, and bays, and box, upon a holly-stock; because they are plants that come all winter. It were good to try it also with grafts of other trees, either fruit trees, or wild trees; to see whether they will not yield their fruit, or bear their leaves later and longer in the winter; because the sap of the holly putteth forth most in the winter. It may be also a mezerion-tree, grafted upon a holly, will prove both an earlier and a greater tree.

593. There be some plants that bear no flower, and yet bear fruit; there be some that bear flowers, and no fruit; there be some that bear neither flowers nor fruit. Most of the great timber-trees (as oaks, beeches, &c.) bear no apparent flowers; some few likewise of the fruit trees (as mulberry, walnuts, &c.) and some shrubs (as juniper, holly, &c.) bear no flowers. Divers herbs also bear seeds (which is as the fruit) and yet bear no flowers; as purslane, &c. Those that bear flowers and no fruit are few; as the double cherry, the sallow, &c. But for the cherry, it is doubtful whether it be not by art or culture; for if it be by art, then trial would be made whether apples' and other fruits' blossoms may not be doubled. There are some few that bear neither fruit nor flower; as the elm, the poplars, box, brakes, &c.

594. There be some plants that shoot still upwards and can support themselves; as the greatest part of trees and plants; there be some other that creep along the ground, or wind about other trees or props, and cannot support themselves; as vines, ivy, briar, briony, woodbines, hops, clematis, camomile, &c. The cause is (as hath been partly touched) for that all plants naturally move upwards; but if the sap put up too fast, it maketh a slender stalk, which will not support the weight; and therefore these latter sort are all swift and hasty comers.

Experiments in consort touching all manner of composts and helps of ground.

595. The first and most ordinary help is stercoration. The sheep's dung is one of the best; and next, the dung of kine; and thirdly, that of horses; which is held to be somewhat too hot unless it be mingled. That of pigeons for a garden, or a small quantity of ground, excelleth. The ordering of dung is, if the

ground be arable, to spread it immediately before the ploughing and sowing; and so to plough it in: for if you spread it long before, the sun will draw out much of the fatness of the dung: if the ground be grazing ground, to spread it somewhat late, towards winter; that the sun may have the less power to dry it up. As for special composts for gardens, (as a hot bed, &c.) we have handled them before.

596. The second kind of compost is the spreading of divers kinds of earths; as marl, chalk, sea-sand, earth upon earth, pond-earth; and the mixtures of them. Marl is thought to be the best; as having most fatness, and not heating the ground too much. The next is sea-sand, which (no doubt) obtaineth a special virtue by the salt: for salt is the first rudiment of life. Chalk over-heateth the ground a little; and therefore is best upon cold clay grounds, or moist grounds: but I heard a great husband say that it was a common error to think that chalk helpeth arable grounds, but helpeth not grazing grounds; whereas indeed it helpeth grass as well as corn: but that which breedeth the error is, because after the chalking of the ground they wear it out with many crops without rest, and then indeed afterwards it will bear little grass, because the ground is tired out. It were good to try the laying of chalk upon arable grounds a little while before ploughing; and to plough it in, as they do the dung; but then it must be friable first by rain or lying. As for earth, it compasseth itself; for I knew a great garden that had a field (in a manner) poured upon it, and it did bear fruit excellently the first year of the planting: for the surface of the earth is ever the fruitfullest. And earth so prepared hath a double surface. But it is true, as I conceive, that such earth as hath salt-petre bred in it, if you can procure it without too much charge, doth excel. The way to hasten the breeding of salt-petre, is to forbid the sun, and the growth of vegetables. And therefore if you make a large hovel, thatched, over some quantity of ground; nay, if you do but plank the ground over, it will breed salt-petre. As for pond-earth, or river-earth, it is a very good compost, especially if the pond have been long uncleansed, and so the water be not too hungry: and I judge it will be yet better if there be some mixture of chalk.

597. The third help of ground is, by some other substances that have virtue to make ground fertile, though they be not

merely earth; wherein ashes excel; insomuch as the countries about Ætna and Vesuvius have a kind of amends made them for the mischief the eruptions many times do, by the exceeding fruitfulness of the soil, caused by the ashes scattered about.[1] Soot also, though thin spread in a field or garden, is tried to be a very good compost. For salt, it is too costly; but it is tried, that mingled with seed-corn, and sown together, it doth good; and I am of opinion, that chalk in powder, mingled with seed-corn, would do good; perhaps as much as chalking the ground all over. As for the steeping of the seeds in several mixtures with water to give them vigour, or watering grounds with compost-water, we have spoken of them before.

598. The fourth help of ground is, the suffering of vegetables to die into the ground, and so to fatten it; as the stubble of corn, especially peas. Brakes cast upon the ground in the beginning of winter, will make it very fruitful. It were good also to try whether leaves of trees swept together, with some chalk and dung mixed, to give them more heart, would not make a good compost; for there is nothing lost so much as leaves of trees; and as they lie scattered, and without mixture, they rather make the ground sour than otherwise.

599. The fifth help of ground is, heat and warmth. It hath been anciently practised to burn heath, and ling, and sedge, with the vantage of the wind, upon the ground. We see that warmth of walls and inclosures mendeth ground: we see also, that lying open to the south mendeth ground: we see again, that the foldings of sheep help ground, as well by their warmth as by their compost: and it may be doubted, whether the covering of the ground with brakes in the beginning of the winter (whereof we spake in the last experiment) helpeth it not, by reason of the warmth. Nay, some very good husbands do suspect that the gathering up of flints in flinty ground, and laying them on heaps, (which is much used,) is no good husbandry; for that they would keep the ground warm.

600. The sixth help of ground is by watering and irrigation; which is in two manners; the one by letting in and shutting out waters at seasonable times: for water at some seasons, and with reasonable stay, doth good; but at some other seasons, and with too long stay, doth hurt: and this serveth only for meadows which are along some river. The other

[1] Sandys's Travels, p. 203.

way is, to bring water from some hanging grounds where there are springs into the lower grounds, carrying it in some long furrows; and from those furrows, drawing it traverse to spread the water. And this maketh an excellent improvement, both for corn and grass. It is the richer if those hanging grounds be fruitful, because it washeth off some of the fatness of the earth; but howsoever it profiteth much. Generally where there are great overflows, in fens or the like, the drowning of them in the winter maketh the summer following more fruitful; the cause may be, for that it keepeth the ground warm, and nourisheth it. But the fen-men hold that the sewers must be kept so, as the water may not stay too long in the spring, till the weeds and sedge be grown up; for then the ground will be like a wood, which keepeth out the sun, and so continueth the wet; whereby it will never graze (to purpose) that year. Thus much for irrigation. But for avoidances and drainings of water, where there is too much, and the helps of ground in that kind, we shall speak of them in another place.

NATURAL HISTORY.

CENTURY VII.

Experiments in consort touching the affinities and differences between plants and inanimate bodies.

601. THE differences between animate and inanimate bodies, we shall handle fully under the title of life, and living spirits, and powers. We shall therefore make but a brief mention of them in this place. The main differences are two. All bodies have spirits and pneumatical parts within them: but the main differences between animate and inanimate are two: the first is, that the spirits of things animate are all continued with themselves, and are branched in veins and secret canals, as blood is: and in living creatures, the spirits have not only branches, but certain cells or seats, where the principal spirits do reside, and whereunto the rest do resort; but the spirits in things inanimate are shut in and cut off by the tangible parts, and are not pervious one to another; as air is in snow. The second main difference is, that the spirits of animate bodies are all in some degree (more or less) kindled and inflamed; and have a fine commixture of flame, and an aërial substance. But inanimate bodies have their spirits no whit inflamed or kindled. And this difference consisteth not in the heat or coolness of spirits; for cloves and other spices, naphtha and petroleum, have exceeding hot spirits, (hotter a great deal than oil, wax, or tallow, &c.) but not inflamed. And when any of those weak and temperate bodies come to be inflamed, then they gather a much greater heat than others have uninflamed; besides their light and motion, &c.

602. The differences, which are secondary, and proceed from

these two radical differences, are: First, plants are all figurate and determinate; which inanimate bodies are not; for look how far the spirit is able to spread and continue itself, so far goeth the shape of figure, and then is determined. Secondly, plants do nourish; inanimate bodies do not; they have an accretion, but no alimentation. Thirdly, plants have a period of life; which inanimate bodies have not. Fourthly, they have a succession and propagation of their kind; which is not in bodies inanimate.

603. The differences between plants, and metals or fossils, besides those four before-mentioned (for metals I hold inanimate), are these: First, metals are more durable than plants. Secondly, they are more solid and hard. Thirdly, they are wholly subterrany; whereas plants are part above earth and part under earth.

604. There be very few creatures that participate of the nature of plants and metals both; coral is one of the nearest of both kinds: another is vitriol, for that is aptest to sprout with moisture.

605. Another special affinity is between plants and mould or putrefaction; for all putrefaction (if it dissolve not in arefaction) will in the end issue into plants or living creatures bred of putrefaction. I account moss, and mushrooms, and agaric, and other of those kinds, to be but moulds of the ground, walls, and trees, and the like. As for flesh, and fish, and plants themselves, and a number of other things, after a mouldiness, or rottenness, or corrupting, they will fall to breed worms. These putrefactions, which have affinity with plants, have this difference from them; that they have no succession or propagation, though they nourish, and have a period of life, and have likewise some figure.

606. I left once by chance a citron cut, in a close room, for three summer months that I was absent; and at my return there were grown forth, out of the pith cut, tufts of hairs an inch long, with little black heads, as if they would have been some herb.

Experiments in consort touching the affinities and differences of plants and living creatures, and the confiners and participles of them.

607. The affinities and differences between plants and living

creatures are these that follow. They have both of them spirits continued, and branched, and also inflamed. But first, in living creatures the spirits have a cell or seat, which plants have not; as was also formerly said. And secondly, the spirits of living creatures hold more of flame than the spirits of plants do. And these two are the radical differences. For the secondary differences, they are as follow. First, plants are all fixed to the earth; whereas all living creatures are severed, and of themselves. Secondly, living creatures have local motion; plants have not. Thirdly, living creatures nourish from their upper parts, by the mouth chiefly; plants nourish from below, namely from the roots. Fourthly, plants have their seed and seminal parts uppermost; living creatures have them lowermost: and therefore it was said, not elegantly alone, but philosophically; *Homo est planta inversa*[1]; Man is like a plant turned upwards: for the root in plants is as the head in living creatures. Fifthly, living creatures have a more exact figure than plants. Sixthly, living creatures have more diversity of organs within their bodies, and (as it were) inward figures, than plants have. Seventhly, living creatures have sense, which plants have not. Eighthly, living creatures have voluntary motion, which plants have not.

608. For the difference of sexes in plants, they are oftentimes by name distinguished; as male-piony, female-piony; male-rosemary, female-rosemary; he-holly, she-holly, &c.; but generation by copulation certainly extendeth not to plants. The nearest approach of it is between the he-palm and the she-palm; which (as they report), if they grow near, incline the one to the other; insomuch as (that which is more strange) they doubt not to report, that to keep the trees upright from bending, they tie ropes or lines from the one to the other, that the contact might be enjoyed by the contact of a middle body. But this may be feigned, or at least amplified. Nevertheless I am apt enough to think, that this same *binarium* of a stronger and a weaker, like unto masculine and feminine, doth hold in

[1] See Scaliger, *Exercit. adv. Cardan.* 141. 2. The dictum in the text is founded upon what is said by Aristotle, *De Juvent. et Senect.* c. 1. But the analogy though ingenious is unsatisfactory, animals being in truth more analogous to leaves than to whole plants. But here we encounter one of the most difficult of all questions; namely, what constitutes individuality? a question which runs through all ontological systems and reappears in morphology; one of the many instances which show how impossible it is to degrade physical science into empiricism.

all living bodies. It is confounded sometimes; as in some creatures of putrefaction, wherein no marks of distinction appear: and it is doubled sometimes; as in hermaphrodites: but generally there is a degree of strength in most species.

609. The participles or confiners between plants and living creatures, are such chiefly as are fixed, and have no local motion of remove, though they have a motion in their parts; such as are oysters, cockles, and such like. There is a fabulous narration, that in the northern countries there should be an herb that groweth in the likeness of a lamb, and feedeth upon the grass, in such sort as it will bare the grass round about.[1] But I suppose that the figure maketh the fable; for so we see there be bee-flowers, &c. And as for the grass, it seemeth the plant, having a great stalk and top, doth prey upon the grass a good way about, by drawing the juice of the earth from it.

Experiments promiscuous touching plants.

610. The Indian fig boweth his roots down so low in one year, as of itself it taketh root again; and so multiplieth from root to root, making of one tree a kind of wood.[2] The cause is the plenty of the sap, and the softness of the stalk, which maketh the bough, being over-loaden, and not stiffly upheld, weigh down. It hath leaves as broad as a little target, but the fruit no bigger than beans. The cause is, for that the continual shade increaseth the leaves, and abateth the fruit; which nevertheless is of a pleasant taste. And that (no doubt) is caused by the suppleness and gentleness of the juice of that plant, being that which maketh the boughs also so flexible.

611. It is reported by one of the ancients that there is a certain Indian tree, having few but very great leaves, three cubits long and two broad, and that the fruit, being of good taste, groweth out of the bark.[3] It may be, there be plants that pour out the sap so fast, as they have no leisure either to divide into many leaves, or to put forth stalks to the fruit. With us, trees (generally) have small leaves in comparison. The fig hath the greatest; and next it the vine, mulberry, and sycamore; and the least are those of the willow, birch, and

[1] Cardan, De Rerum Variet. xxii. p. 63. The name given to this herb in the country where it grows is *borametz*, sc. *quasi agnus*.

[2] See Pliny, xx. 11.

[3] Id. xii. 12. But it is not said that the tree has but few leaves.

thorn. But there be found herbs with far greater leaves than any tree; as the bur, gourd, cucumber, and colewort. The cause is (like to that of the Indian fig) the hasty and plentiful putting forth of the sap.

612. There be three things in use for sweetness; sugar, honey, manna. For sugar, to the ancients it was scarce known, and little used.[1] It is found in canes: *Quære*, whether to the first knuckle, or further up? And whether the very bark of the cane itself do yield sugar, or no? For honey, the bee maketh it, or gathereth it; but I have heard from one that was industrious in husbandry, that the labour of the bee is about the wax; and that he hath known in the beginning of May honeycombs empty of honey; and within a fortnight, when the sweet dews fall, filled like a cellar.[2] It is reported by some of the ancients, that there is a tree called occhus, in the valleys of Hyrcania, that distilleth honey in the mornings.[3] It is not unlike that the sap and tears of some trees may be sweet. It may be also, that some sweet juices, fit for many uses, may be concocted out of fruits, to the thickness of honey, or perhaps of sugar; the likeliest are raisins of the sun, figs, and currants; the means may be inquired.

613. The ancients report of a tree by the Persian sea, upon the shore-sands, which is nourished with the salt water; and when the tide ebbeth, you shall see the roots as it were bare without bark, (being as it seemeth corroded by the salt), and grasping the sands like a crab; which nevertheless beareth a fruit.[4] It were good to try some hard trees, as a service-tree, or fir-tree, by setting them within the sands.

614. There be of plants which they use for garments, these that follow: hemp, flax, cotton, nettles (whereof they make nettle-cloth), sericum, which is a growing silk; they make also cables of the bark of lime trees.[5] It is the stalk that

[1] Pliny, xii. 17.

[2] Bacon's informant took the same view of the matter as Aristotle, and probably was directly or indirectly influenced by his opinion. According to Aristotle the bees manufacture the wax from flowers, but simply collect the honey which falls from the sky. He gives the reason in the text for this opinion, namely, the rapidity with which honey is stored up at certain seasons; and adds another argument, that if the bees are deprived of their honey in the autumn they appear to be unable to supply the loss, although there is still an abundance of flowers. The statement made in a subsequent paragraph, that a bee sometimes lives seven years, may also have been taken from Aristotle, *Hist. Anim.* v. 22.

[3] Pliny, xii. 18.

[4] Id. xii. 20.

[5] The common garden matting which comes to us from Russia is also made of this bark; and the same material, the philyra of the ancients, is used in Esthonia for shoes.

maketh the filaceous matter commonly; and sometimes the down that groweth above.

615. They have in some countries a plant of a rosy colour, which shutteth in the night, openeth in the morning, and openeth wide at noon; which the inhabitants of those countries say is a plant that sleepeth.[1] There be sleepers enow, then; for almost all flowers do the like.

616. Some plants there are, but rare, that have a mossy or downy root; and likewise that have a number of threads, like beards; as mandrakes, whereof witches and impostors make an ugly image, giving it the form of a face at the top of the root, and leaving those strings to make a broad beard down to the foot.[2] Also there is a kind of nard in Crete (being a kind of phu), that hath a root hairy, like a rough-footed dove's foot. So as you may see, there are of roots, bulbous roots, fibrous roots, and hirsute roots. And, I take it, in the bulbous, the sap hasteneth most to the air and sun; in the fibrous, the sap delighteth more in the earth, and therefore putteth downward; and the hirsute is a middle between both; that besides the putting forth upwards and downwards, putteth forth in round.

617. There are some tears of trees, which are kembed from the beards of goats: for when the goats bite and crop them, especially in the mornings, the dew being on, the tear cometh forth, and hangeth upon their beards: of this sort is some kind of ladanum.[3]

618. The irrigation of the plane-tree by wine, is reported by the ancients to make it fruitful.[4] It would be tried likewise with roots; for upon seeds it worketh no great effects.

619. The way to carry foreign roots a long way, is to vessel them close in earthen vessels. But if the vessels be not very great, you must make some holes in the bottom, to give some refreshment to the roots; which otherwise (as it seemeth) will decay and suffocate.

620. The ancient cinnamon was, of all other plants, while it grew, the driest; and those things which are known to comfort other plants, did make that more steril; for in showers it pros-

[1] Pliny, xii. 23. The flower was found at Tylos on the Persian Gulph.
[2] Id. xii. 26.
[3] Id. xii. 37. The resin which exudes from the hemp plant is in India collected much in the same way. Not however by the agency of goats, but by sending men through the fields in which the plant is cultivated.
[4] Id. xii. 4.

pered worst; it grew also amongst bushes of other kinds, where commonly plants do not thrive; neither did it love the sun.[1] There might be one cause of all those effects; namely, the sparing nourishment which that plant required. *Quære*, how far cassia, which is now the substitute of cinnamon, doth participate of these things?

621. It is reported by one of the ancients, that cassia, when it is gathered, is put into the skins of beasts newly flayed; and that the skins corrupting and breeding worms, the worms do devour the pith and marrow of it, and so make it hollow; but meddle not with the bark, because to them it is bitter.[2]

622. There were in ancient time vines of far greater bodies than we know any; for there have been cups made of them, and an image of Jupiter. But it is like they were wild vines; for the vines that they use for wine, are so often cut, and so much digged and dressed, that their sap spendeth into the grapes, and so the stalk cannot increase much in bulk. The wood of vines is very durable, without rotting. And that which is strange, though no tree hath the twigs, while they are green, so brittle, yet the wood dried is extreme tough; and was used by the captains of armies amongst the Romans for their cudgels.[3]

623. It is reported that in some places vines are suffered to grow like herbs, spreading upon the ground; and that the grapes of those vines are very great. It were good to make trial, whether plants that use to be borne up by props, will put forth greater leaves and greater fruits, if they be laid along the ground; as hops, ivy, woodbine, &c.

624. Quinces or apples, &c., if you will keep them long, drown them in honey; but because honey (perhaps) will give them a taste over-luscious, it were good to make trial in powder of sugar, or in syrup of wine only boiled to height. Both these would likewise be tried in oranges, lemons, and pomegranates; for the powder of sugar, and syrup of wine, will serve for times more than once.

625. The conservation of fruit would be also tried in vessels filled with fine sand, or with powder of chalk; or in meal and flour; or in dust of oak wood; or in mill.

626. Such fruits as you appoint for long keeping, you must gather before they be full ripe; and in a fair and dry day,

[1] Pliny, xii. 42. [2] Id. xii. 43. [3] Id. xiv. 2. and 3.

towards noon; and when the wind bloweth not south; and when the moon is under the earth, and in decrease.

627. Take grapes, and hang them in an empty vessel well stopped; and set the vessel not in a cellar, but in some dry place; and it is said they will last long. But it is reported by some, they will keep better in a vessel half full of wine, so that the grapes touch not the wine.[1]

628. It is reported that the preserving of the stalk helpeth to preserve the grape; especially if the stalk be put into the pith of elder, the elder not touching the fruit.

629. It is reported by some of the ancients that fruit put in bottles, and the bottles let down into wells under water, will keep long.

630. Of herbs and plants, some are good to eat raw; as lettuce, endive, purslane, tarragon, cresses, cucumbers, musk-melons, radish, &c. Others only after they are boiled, or have passed the fire; as parsley, clary, sage, parsnips, turnips, asparagus, artichokes (though they also being young are eaten raw). But a number of herbs are not esculent at all; as wormwood, grass, green corn, centory, hyssop, lavender, balm, &c. The causes are, for that the herbs that are not esculent do want the two tastes in which nourishment resteth; which are fat and sweet; and have (contrariwise) bitter and over-strong tastes, or a juice so crude as cannot be ripened to the degree of nourishment. Herbs and plants that are esculent raw, have fatness or sweetness (as all esculent fruits); such are onions, lettuce, &c. But then it must be such a fatness, (for as for sweet things, they are, in effect, always esculent,) as is not over-gross, and loading of the stomach: for parsnips and leeks have fatness, but it is too gross and heavy without boiling. It must be also in a substance somewhat tender; for we see wheat, barley, artichokes, are no good nourishment till they have passed the fire; but the fire doth ripen, and maketh them soft and tender, and so they become esculent. As for radish and tarragon, and the like, they are for condiments, and not for nourishment. And even some of those herbs which are not esculent, are notwithstanding poculent; as hops, broom, &c. *Quære*, what herbs are good for drink besides the two aforenamed; for that it may perhaps ease the

[1] The substance of this and the two next paragraphs is in Pliny, xv. 18.

charge of brewing, if they make beer to require less malt, or make it last longer.

631. Parts fit for the nourishment of man in plants are, seeds, roots, and fruits; but chiefly seeds and roots. For leaves, they give no nourishment at all, or very little: no more do flowers, or blossoms, or stalks. The reason is, for that roots, and seeds, and fruits, (inasmuch as all plants consist of an oily and watery substance commixed,) have more of the oily substance; and leaves, flowers, &c., of the watery. And secondly, they are more concocted; for the root which continueth ever in the earth, is still concocted by the earth; and fruits and grains (we see) are half a year or more in concocting; whereas leaves are out and perfect in a month.

632. Plants (for the most part) are more strong both in taste and smell in the seed, than in the leaf and root. The cause is, for that in plants that are not of a fierce and eager spirit, the virtue is increased by concoction and maturation, which is ever most in the seed; but in plants that are of a fierce and eager spirit, they are stronger whilst the spirit is inclosed in the root, and the spirits do but weaken and dissipate when they come to the air and sun; as we see in onions, garlick, dragon, &c. Nay, there be plants that have their roots very hot and aromatical, and their seeds rather insipid; as ginger. The cause is (as was touched before) for that the heat of those plants is very dissipable; which under the earth is contained and held in; but when it cometh to the air it exhaleth.

633. The juices of fruits are either watery or oily. I reckon among the watery, all the fruits out of which drink is expressed; as the grape, the apple, the pear, the cherry, the pomegranate, &c. And there are some others which, though they be not in use for drink, yet they appear to be of the same nature; as plums, services, mulberries, rasps, oranges, lemons, &c. And for those juices that are so fleshy as they cannot make drink by expression, yet perhaps they may make drink by mixture of water.

Poculaque admistis imitantur vitea sorbis.[1]

And it may be heps and briar-berries would do the like. Those that have oily juices, are olives, almonds, nuts of all

[1] Virg. Georg. iii. 379.

sorts, pine-apples, &c.; and their juices are all inflammable. And you must observe also, that some of the watery juices, after they have gathered spirit, will burn and inflame; as wine. There is a third kind of fruit that is sweet, without either sharpness or oiliness: such as is the fig and the date.

634. It hath been noted, that most trees, and specially those that bear mast, are fruitful but once in two years. The cause (no doubt) is the expence of sap; for many orchard trees, well cultured, will bear divers years together.

635. There is no tree which, besides the natural fruit, doth bear so many bastard fruits as the oak doth: for besides the acorn, it beareth galls, oak-apples, and certain oak-nuts, which are inflammable; and certain oak-berries, sticking close to the body of the tree without stalk. It beareth also misseltoe, though rarely. The cause of all these may be, the closeness and solidness of the wood and pith of the oak; which maketh several juices find several eruptions. And therefore if you will devise to make any super-plants, you must ever give the sap plentiful rising and hard issue.

636. There are two excrescences which grow upon trees; both of them in the nature of mushrooms: the one the Romans call boletus[1]; which groweth upon the roots of oaks, and was one of the dainties of their table; the other is medicinal, that is called agaric (whereof we have spoken before), which groweth upon the tops of oaks; though it be affirmed by some that it groweth also at the roots. I do conceive that many excrescences of trees grow chiefly where the tree is dead or faded; for that the natural sap of the tree corrupteth into some preternatural substance.

637. The greater part of trees bear most and best on the lower boughs; as oaks, figs, walnuts, pears, &c.; but some bear best on the top-boughs; as crabs, &c. Those that bear best below, are such as shade doth more good to than hurt. For generally all fruits bear best lowest, because the sap tireth not, having but a short way: and therefore in fruits spread upon walls, the lowest are the greatest, as was formerly said: so it is the shade that hindereth the lower boughs; except it be in such trees as delight in shade, or at least bear it well. And therefore they are either strong trees, as the oak; or else they have large leaves, as the walnut and fig; or else they grow in

[1] Pliny, xvi. 11. and 13.

pyramis, as the pear. But if they require very much sun, they bear best on the top; as it is in crabs, apples, plums, &c.

638. There be trees that bear best when they begin to be old; as almonds, pears, vines, and all trees that give mast. The cause is, for that all trees that bear mast have an oily fruit; and young trees have a more watery juice, and less concocted; and of the same kind also is the almond.[1] The pear likewise, though it be not oily, yet it requireth much sap, and well concocted; for we see it is a heavy fruit and solid, much more than apples, plums, &c. As for the vine, it is noted that it beareth more grapes when it is young; but grapes that make better wine when it is old; for that the juice is the better concocted; and we see that wine is inflammable, so as it hath a kind of oiliness. But the most part of trees, amongst which are apples, plums, &c., bear best when they are young.

639. There be plants that have a milk in them when they are cut; as figs, old lettuce, sow-thistles, spurge, &c. The cause may be an inception of putrefaction: for those milks have all an acrimony: though one would think they should be lenitive. For if you write upon paper with the milk of the fig, the letters will not be seen, until you hold the paper before the fire, and then they wax brown; which sheweth that it is a sharp or fretting juice: lettuce is thought poisonous, when it is so old as to have milk: spurge is a kind of poison in itself: and as for sow-thistles, though coneys eat them, yet sheep and cattle will not touch them: and besides, the milk of them rubbed upon warts, in short time weareth them away; which sheweth the milk of them to be corrosive. We see also that wheat and other corn sown, if you take them forth of the ground before they sprout, are full of milk; and the beginning of germination is ever a kind of putrefaction of the seed. Euphorbium also hath a milk, though not very white, which is of a great acrimony: and saladine hath a yellow milk, which hath likewise much acrimony; for it cleanseth the eyes. It is good also for cataracts.

[1] Whatever the reason may be, it is certainly true that the produce of the olive increases with the age of the tree, at least for a long period of years. It is said to be on this account that olive grounds are in France far less remunerative than in Italy or Spain, because hard winters occasionally occur and prevent the trees from attaining their full age. From the experience of the last century and a half it seems that in France a frost occurs sufficiently severe to destroy the trees about once in forty years. The statement with regard to the vine is taken from Pliny.

640. Mushrooms are reported to grow as well upon the bodies of trees, as upon their roots, or upon the earth; and especially upon the oak. The cause is, for that strong trees are, towards such excrescences, in the nature of earth; and therefore put forth moss, mushrooms, and the like.

641. There is hardly found a plant that yieldeth a red juice in the blade or ear; except it be the tree that beareth sanguis draconis; which groweth chiefly in the island Soquotra: the herb amaranthus indeed is red all over; and brasil is red in the wood: and so is red sanders. The tree of sanguis draconis groweth in the form of a sugar-loaf. It is like that the sap of that plant concocteth in the body of the tree. For we see that grapes and pomegranates are red in the juice, but are green in the tear: and this maketh the tree of sanguis draconis lesser towards the top; because the juice hasteneth not up; and besides, it is very astringent; and therefore of slow motion.

642. It is reported that sweet moss, besides that upon the apple trees, groweth likewise sometimes upon poplars; and yet (generally) the poplar is a smooth tree of bark, and hath little moss. The moss of the larix-tree burneth also sweet, and sparkleth in the burning. *Quære* of the mosses of odorate trees; as cedar, cypress, lignum aloës, &c.

643. The death that is most without pain, hath been noted to be upon the taking of the potion of hemlock; which in humanity was the form of execution of capital offenders in Athens. The poison of the asp, that Cleopatra used, hath some affinity with it. The cause is, for that the torments of death are chiefly raised by the strife of the spirits; and these vapours quench the spirits by degrees; like to the death of an extreme old man. I conceive it is less painful than opium, because opium hath parts of heat mixed.

644. There be fruits that are sweet before they be ripe, as myrobalanes; so fennel-seeds are sweet before they ripen, and after grow spicy. And some never ripen to be sweet; as tamarinds, berberries, crabs, sloes, &c. The cause is, for that the former kind have much and subtile heat, which causeth early sweetness; the latter have a cold and acid juice, which no heat of the sun can sweeten. But as for the myrobalane, it hath parts of contrary natures; for it is sweet, and astringent.

645. There be few herbs that have a salt taste; and contrariwise all blood of living creatures hath a saltness. The cause

may be, for that salt, though it be the rudiment of life, yet in plants the original taste remaineth not; for you shall have them bitter, sour, sweet, biting, but seldom salt; but in living creatures, all those high tastes may happen to be (sometimes) in the humours, but are seldom in the flesh or substance; because it is of a more oily nature; which is not very susceptible of those tastes; and the saltness itself of blood is but a light and secret saltness: and even among plants, some do participate of saltness, as alga marina, sampire, scurvy-grass, &c. And they report, there is in some of the Indian seas a swimming plant, which they call salgazus [1], spreading over the sea, in such sort as one would think it were a meadow. It is certain that out of the ashes of all plants they extract a salt which they use in medicines.

646. It is reported by one of the ancients, that there is an herb growing in the water, called lincostis [2], which is full of prickles: this herb putteth forth another small herb out of the leaf; which is imputed to some moisture that is gathered between the prickles, which putrefied by the sun germinateth. But I remember also I have seen, for a great rarity, one rose grow out of another, like honeysuckles, that they call top and top-gallants.

647. Barley (as appeareth in the malting) being steeped in water three days, and afterwards the water drained from it, and the barley turned upon a dry floor, will sprout half an inch long at least: and if it be let alone, and not turned, much more; until the heart be out. Wheat will do the same. Try it also with peas and beans. This experiment is not like that of the orpine and semper-vive; for there it is of the old store, for no water is added; but here it is nourished from the water. The experiment would be further driven: for it appeareth already, by that which hath been said, that earth is not necessary to the first sprouting of plants; and we see that rose-buds set in water will blow: therefore try whether the sprouts of such grains may not be raised to a further degree; as to an herb, or flower, with water only, or some small commixture of earth: for if they will, it should seem by the experiments before, both of the malt and of the roses, that they will come far

[1] Cardan, De Subtilit. viii. p. 257. Salgazus is, of course, the same as Sargasso, and Bacon was thinking of the Mar di Sargasso in the Atlantic.

[2] See Cardan, De Subtil. viii. p. 259., who refers to Aristotle, in whose works however no plant of that name is, I believe, mentioned

faster on in water than in earth; for the nourishment is easilier drawn out of water than out of earth. It may give some light also, that drink infused with flesh, as that with the capon, &c., will nourish faster and easilier than meat and drink together. Try the same experiment with roots as well as with grains: as for example, take a turnip, and steep it a while, and then dry it, and see whether it will sprout.

648. Malt in the drenching will swell; and that in such a manner, as after the putting forth in sprouts, and the drying upon the kiln[1], there will be gained at least a bushel in eight, and yet the sprouts are rubbed off; and there will be a bushel of dust besides the malt; which I suppose to be, not only by the loose and open laying of the parts, but by some addition of substance, drawn from the water in which it was steeped.

649. Malt gathereth a sweetness to the taste, which appeareth yet more in the wort. The dulcoration of things is worthy to be tried to the full; for that dulcoration importeth a degree to nourishment: and the making of things inalimental to become alimental, may be an experiment of great profit for making new victual.

650. Most seeds in the growing, leave their husk or rind about the root; but the onion will carry it up, that it will be like a cap upon the top of the young onion. The cause may be, for that the skin or husk is not easy to break; as we see by the pilling of onions, what a holding substance the skin is.

651. Plants, that have curled leaves, do all abound with moisture; which cometh so fast on, as they cannot spread themselves plain, but must needs gather together. The weakest kind of curling is roughness; as in clary and bur: the second is curling on the sides; as in lettuce, and young cabbage: and the third is folding into an head; as in cabbage full grown and cabbage-lettuce.

652. It is reported that fir and pine, especially if they be old and putrefied, though they shine not as some rotten woods do, yet in the sudden breaking they will sparkle like hard sugar.

653. The roots of trees do (some of them) put downwards deep into the ground; as the oak, pine, fir, &c. Some spread more towards the surface of the earth; as the ash, cypress-tree, olive, &c. The cause of this latter may be, for that such trees

[1] *Keele* in the original. — *J. S.*

as love the sun, do not willingly descend far into the earth; and therefore they are (commonly) trees that shoot up much; for in their body, their desire of approach to the sun maketh them spread the less. And the same reason, under ground, to avoid recess from the sun, maketh them spread the more. And we see it cometh to pass in some trees which have been planted too deep in the ground, that for love of approach to the sun, they forsake their first root, and put out another more towards the top of the earth. And we see also that the olive is full of oily juice; and ash maketh the best fire; and cypress is an hot tree. As for the oak, which is of the former sort, it loveth the earth; and therefore groweth slowly. And for the pine, and fir likewise, they have so much heat in themselves, as they need less the heat of the sun. There be herbs also that have the same difference; as the herb they call morsus diaboli[1]: which putteth the root down so low, as you cannot pull it up without breaking; which gave occasion to the name and fable; for that it was said, it was so wholesome a root, that the devil, when it was gathered, bit it for envy: and some of the ancients do report that there was a goodly fir, (which they desired to remove whole,) that had a root underground eight cubits deep; and so the root came up broken.[2]

654. It hath been observed that a branch of a tree, being unbarked some space at the bottom, and so set into the ground, hath grown; even of such trees as, if the branch were set with the bark on, they would not grow; yet contrariwise we see that a tree pared round in the body above ground, will die. The cause may be, for that the unbarked part draweth the nourishment best, but the bark continueth it only.

655. Grapes will continue fresh and moist all winter long, if you hang them cluster by cluster in the roof of a warm room; especially if when you gather the cluster, you take off with the cluster some of the stock.

656. The reed or cane is a watery plant, and groweth not but in the water: it hath these properties: that it is hollow; that it is knuckled both stalk and root; that being dry, it is more hard and fragile than other wood; that it putteth forth no boughs, though many stalks come out of one root. It differeth much in greatness; the smallest being fit for thatching of

[1] Apparently a kind of scabious. See Gerard's Herbal. p. 726.
[2] Pliny, xvi. 56.

houses, and stopping the chinks of ships, better than glue or pitch. The second bigness is used for angle-rods and staves; and in China for beating of offenders upon the thighs. The differing kinds of them are, the common reed, the cassia fistula, and the sugar-reed. Of all plants it boweth the easiest and riseth again. It seemeth that amongst plants which are nourished with mixture of earth and water, it draweth most nourishment from water; which maketh it the smoothest of all others in bark, and the hollowest in body.

657. The sap of trees when they are let blood, is of differing natures. Some more watery and clear; as that of vines, of beeches, of pears. Some thick, as apples. Some gummy, as cherries. Some frothy, as elms. Some milky, as figs. In mulberries the sap seemeth to be (almost) towards the bark only; for if you cut the tree a little into the bark with a stone, it will come forth; if you pierce it deeper with a tool, it will be dry. The trees which have the moistest juices in their fruit, have commonly the moistest sap in their body; for the vines and pears are very moist; apples somewhat more spongy: the milk of the fig hath the quality of the rennet, to gather cheese; and so have certain sour herbs wherewith they make cheese in Lent.[1]

658. The timber and wood are in some trees more clean, in some more knotty; and it is a good trial to try it by speaking at one end, and laying the ear at the other; for if it be knotty, the voice will not pass well. Some have the veins more varied and chamlotted[2], as oak, whereof wainscot is made; maple, whereof trenchers are made: some more smooth, as fir and walnut: some do more easily breed worms and spiders; some more hardly, as it is said of Irish trees: besides there be a number of differences that concern their use; as oak, cedar, and chesnut, are the best builders; some are best for plough-timber, as ash; some for piers, that are sometimes wet and sometimes dry, as elm; some for planchers, as deal; some for tables, cupboards, and desks, as walnuts: some for ship-timber, as oaks that grow in moist grounds; for that maketh the timber tough, and not apt to rift with ordnance; wherein English and

[1] The Greeks appear to have employed the juice of the fig for making cheese, as familiarly as rennet. Bacon's information on the subject was probably taken from Aristotle, *Hist. Animal.* iii. 21. Ælian mentions the use of the juice of a kind of thistle for the same purpose.

[2] So spelt here in the original. Compare Exp. 741. where it is spelt *chamoletted.* —*J. S.*

Irish timber are thought to excel: some for masts of ships, as fir and pine, because of their length, straightness, and lightness: some for pale, as oak: some for fuel, as ash; and so of the rest.

659. The coming of trees and plants in certain regions, and not in others, is sometimes casual: for many have been translated, and have prospered well; as damask-roses, that have not been known in England above an hundred years, and now are so common. But the liking of plants in certain soils more than in others, is merely natural; as the fir and pine love the mountains; the poplar, willow, sallow, and alder, love rivers and moist places; the ash loveth coppices, but is best in standards alone; juniper loveth chalk; and so do most fruit trees; sampire groweth but upon rocks; reeds and osiers grow where they are washed with water; the vine loveth sides of hills, turning upon the south-east sun, &c.

660. The putting forth of certain herbs discovereth of what nature the ground where they put forth is; as wild thyme sheweth good feeding-ground for cattle; betony and strawberries shew grounds fit for wood; camomile sheweth mellow grounds fit for wheat. Mustard-seed, growing after the plough, sheweth a good strong ground also for wheat: burnet sheweth good meadow; and the like.

661. There are found in divers countries some other plants that grow out of trees and plants, besides misseltoe: as in Syria there is an herb called cassytas, that groweth out of tall trees, and windeth itself about the same tree where it groweth; and sometimes about thorns. There is a kind of polypode that groweth out of trees, though it windeth not. So likewise an herb called faunos, upon the wild olive. And an herb called hippophæston upon the fuller's thorn: which, they say, is good for the falling sickness.[1]

662.[2] It hath been observed by some of the ancients, that howsoever cold and easterly winds are thought to be great enemies to fruit, yet nevertheless south winds are also found to do hurt; especially in the blossoming time; and the more if showers follow. It seemeth they call forth the moisture too fast. The west winds are the best. It hath been observed

[1] All these are mentioned by Pliny, xvi. 92. But *cassytas* ought to be *cadytas*, on his authority and that of Theophrastus, whom he follows.

[2] The substance of this and the two next paragraphs is from Pliny, xvi, 92.

also that green and open winters do hurt trees; insomuch as if two or three such winters come together, almond-trees, and some other trees, will die. The cause is the same with the former, because the lust of the earth over-spendeth itself: howsoever some other of the ancients have commended warm winters.

663. Snows lying long cause a fruitful year; for first they keep in the strength of the earth: secondly, they water the earth better than rain; for in snow, the earth doth (as it were) suck the water as out of the teat: thirdly, the moisture of snow is the finest moisture; for it is the froth of the cloudy waters.

664. Showers, if they come a little before the ripening of fruits, do good to all succulent and moist fruits; as vines, olives, pomegranates; yet it is rather for plenty than for goodness; for the best wines are in the driest vintages: small showers are likewise good for corn, so as parching heats come not upon them. Generally night showers are better than day showers, for that the sun followeth not so fast upon them; and we see, even in watering by the hand, it is best in summer time to water in the evening.

665. The differences of earths, and the trial of them, are worthy to be diligently inquired. The earth, that with showers doth easiliest soften, is commended; and yet some earth of that kind will be very dry and hard before the showers. The earth that casteth up from the plough a great clod, is not so good as that which casteth up a smaller clod. The earth that putteth forth moss easily, and may be called mouldy, is not good. The earth that smelleth well upon the digging or ploughing, is commended; as containing the juice of vegetables almost already prepared. It is thought by some, that the ends of low rainbows fall more upon one kind of earth than upon another; as it may well be; for that that earth is most roscid: and therefore it is commended for a sign of good earth. The poorness of the herbs (it is plain) sheweth the poorness of the earth; and especially if they be in colour more dark: but if the herbs shew withered or blasted at the top, it sheweth the earth to be very cold; and so doth the mossiness of trees. The earth whereof the grass is soon parched with the sun and toasted, is commonly forced earth; and barren in his own

nature.[1] The tender, chessome, and mellow earth is the best; being mere mould, between the two extremes of clay and sand; especially if it be not loamy and binding. The earth that after rain will scarce be ploughed, is commonly fruitful; for it is cleaving, and full of juice.

666. It is strange, which is observed by some of the ancients, that dust helpeth the fruitfulness of trees; and of vines by name; insomuch as they cast dust upon them of purpose.[2] It should seem that that powdering, when a shower cometh, maketh a kind of soiling to the tree, being earth and water finely laid on. And they note that countries where the fields and ways are dusty bear the best vines.

667. It is commended by the ancients, for an excellent help to trees, to lay the stalks and leaves of lupines about the roots; or to plough them into the ground where you will sow corn. The burning also of the cuttings of vines, and casting them upon land, doth much good. And it was generally received of old, that dunging of grounds when the west wind bloweth, and in the decrease of the moon, doth greatly help; the earth (as it seemeth) being then more thirsty and open to receive the dung.

668. The grafting of vines upon vines (as I take it) is not now in use. The ancients had it, and that three ways: the first was incision, which is the ordinary manner of grafting: the second was terebration through the middle of the stock, and putting in the scion there: and the third was paring of two vines that grow together to the marrow, and binding them close.[3]

669. The diseases and ill accidents of corn are worthy to be inquired; and would be more worthy to be inquired, if it were in men's power to help them; whereas many of them are not to be remedied. The mildew is one of the greatest; which (out of question) cometh by closeness of air; and therefore in hills, or large champaign grounds, it seldom cometh; such as is with us *York's Woald.* This cannot be remedied, otherwise than that in countries of small inclosure the grounds be turned into larger fields: which I have known to do good in some farms. Another

[1] All this is taken from Pliny, xvii. 3. The passage is obscure, but it does not seem that Pliny affirms that rainbows rest upon one kind of earth rather than another. He says that a good soil may be known by its odour, and that this odour is the same as that which is produced at the place at which a rainbow touches the ground.

[2] Pliny, xvii. 5.

[3] Id. xvii. 25.

disease is the putting forth of wild oats, whereinto corn oftentimes (especially barley) doth degenerate. It happeneth chiefly from the weakness of the grain that is sown: for if it be either too old or mouldy, it will bring forth wild oats. Another disease is the satiety of the ground; for if you sow one ground still with the same corn, (I mean not the same corn that grew upon the same ground, but the same kind of grain, as wheat, barley, &c.,) it will prosper but poorly: therefore, besides the resting of the ground, you must vary the seed. Another ill accident is from the winds, which hurt at two times; at the flowering, by shaking off the flowers; and at the full ripening, by shaking out the corn. Another ill accident is drouth at the spindling of the corn; which with us is rare, but in hotter countries common: insomuch as the word *calamitas*[1] was first derived from *calamus*, when the corn could not get out of the stalk. Another ill accident is over-wet at sowing time; which with us breedeth much dearth; insomuch as the corn never cometh up; and (many times) they are forced to resow summer-corn where they sowed winter-corn. Another ill accident is bitter frosts, continued, without snow; especially in the beginning of the winter, after the seed is new sown. Another disease is worms; which sometimes breed in the root, and happen upon hot suns and showers immediately after the sowing; and another worm breedeth in the ear itself, especially when hot suns break often out of clouds. Another disease is weeds; and they are such as either choke and overshadow the corn, and bear it down, or starve the corn and deceive it of nourishment. Another disease is over-rankness of the corn: which they use to remedy by mowing it after it is come up, or putting sheep into it. Another ill accident is laying of corn with great rains, near or in harvest. Another ill accident is, if the seed happen to have touched oil, or anything that is fat; for those substances have an antipathy with nourishment of water.

670. The remedies of the diseases of corn have been observed as followeth.[2] The steeping of the grain, before sowing, a little time in wine, is thought a preservative: the

[1] Calamitas is said to mean primarily the destruction of the calamus or stalk, either by storms or by disease. But this derivation seems improbable, and at any rate it does not support Bacon's remark.

[2] The greater part of this paragraph is from Pliny, xviii. 45.

mingling of seed-corn with ashes is thought to be good: the sowing at the wane of the moon is thought to make the corn sound: it hath not been practised, but it is thought to be of use to make some miscellane in corn; as if you sow a few beans with wheat, your wheat will be the better.[1] It hath been observed that the sowing of corn with houseleek doth good. Though grain that toucheth oil or fat receiveth hurt, yet the steeping of it in the dregs of oil when it beginneth to putrefy (which they call *amurca*) is thought to assure it against worms. It is reported also, that if corn be mowed, it will make the grain longer, but emptier, and having more of the husk.

671. It hath been noted, that seed of a year old is the best; and of two or three years is worse; and that which is more old is quite barren; though (no doubt) some seeds and grains last better than others. The corn which in the vanning lieth lowest is the best: and the corn which broken or bitten retaineth a little yellowness, is better than that which is very white.[2]

672. It hath been observed, that of all roots of herbs, the root of sorrel goeth the furthest into the earth; insomuch as it hath been known to go three cubits deep: and that it is the root that continueth fit (longest) to be set again, of any root that groweth.[3] It is a cold and acid herb, that (as it seemeth) loveth the earth, and is not much drawn by the sun.

673. It hath been observed, that some herbs like best being watered with salt water: as radish, beet, rue, pennyroyal[4]; this trial would be extended to some other herbs; especially such as are strong; as tarragon, mustard-seed, rocket, and the like.

674. It is strange that is generally received, how some poisonous beasts affect odorate and wholesome herbs; as that the snake loveth fennel; that the toad will be much under sage; that frogs will be in cinque-foil. It may be it is rather the shade, or other coverture, that they take liking in, than the virtue of the herb.

675. It were a matter of great profit (save that I doubt it is too conjectural to venture upon) if one could discern what

[1] This opinion probably gave rise to the practice, not long since discontinued, of sowing wheat and rye together. The produce was in Scotland called *maug corn*; which, though obviously only a corruption of meng or mingled corn, has been supposed to denote that the practice was a remnant of monastic husbandry.

[2] See Pliny, xviii. 54. [3] Id. xix. 31. [4] Id. xix. 59.

corn, herbs, or fruits, are like to be in plenty or scarcity, by some signs and prognostics in the beginning of the year: for as for those that are like to be in plenty, they may be bargained for upon the ground; as the old relation was of Thales; who, to shew how easy it was for a philosopher to be rich, when he foresaw a great plenty of olives, made a monopoly of them.[1] And for scarcity, men may make profit in keeping better the old store. Long continuance of snow is believed to make a fruitful year of corn: an early winter, or a very late winter, a barren year of corn: an open and serene winter, an ill year of fruit. These we have partly touched before: but other prognostics of like nature are diligently to be inquired.

676. There seem to be in some plants singularities, wherein they differ from all other. The olive hath the oily part only on the outside; whereas all other fruits have it in the nut or kernel. The fir hath (in effect) no stone, nut, nor kernel; except you will count the little grains kernels. The pomegranate and pine-apple have, only amongst fruits, grains distinct in several cells. No herbs have curled leaves but cabbage and cabbage-lettuce. None have double leaves, one belonging to the stalk, another to the fruit or seed, but the artichoke. No flower hath that kind of spread that the woodbine hath. This may be a large field of contemplation; for it sheweth that in the frame of nature there is, in the producing of some species, a composition of matter which happeneth oft, and may be much diversified: in other, such as happeneth rarely, and admitteth little variety. For so it is likewise in beasts: dogs have a resemblance with wolves and foxes; horses with asses; kine with bufles[2]; hares with coneys, &c. And so in birds: kites and kestrels have a resemblance with hawks; common doves with ring-doves and turtles; blackbirds with thrushes and mavises; crows with ravens, daws, and choughs, &c. But elephants and swine amongst beasts; and the bird of paradise and the peacock amongst birds; and some few others, have scarce any other species that have affinity with them.

We leave the description of plants and their virtues to herbals, and other like books of natural history; wherein men's diligence hath been great, even to curiosity: for our experiments are only such as do ever ascend a degree to the

[1] Diog. Laert. i. 26.

[2] So in the original.—*J. S.*

deriving of causes and extracting of axioms; which we are not ignorant but that some both of the ancient and modern writers have also laboured; but their causes and axioms are so full of imagination, and so infected with the old received theories, as they are mere inquinations of experience, and concoct it not.

Experiment solitary touching healing of wounds.

677. It hath been observed by some of the ancients, that skins (especially of rams) newly pulled off, and applied to the wounds of stripes, do keep them from swelling and exulcerating; and likewise heal them and close them up; and that the whites of eggs do the same.[1] The cause is a temperate conglutination; for both bodies are clammy and viscous, and do bridle the deflux of humours to the hurts, without penning them in too much.

Experiment solitary touching fat diffused in flesh.

678. You may turn (almost) all flesh into a fatty substance, if you take flesh, and cut it into pieces, and put the pieces into a glass covered with parchment, and so let the glass stand six or seven hours in boiling water. It may be an experiment of profit for making of fat or grease for many uses; but then it must be of such flesh as is not edible; as horses, dogs, bears, foxes, badgers, &c.[2]

Experiment solitary touching ripening of drink before the time.

679. It is reported by one of the ancients, that new wine put into vessels well stopped, and the vessels let down into the sea, will accelerate very much the making of them ripe and potable.[3] The same would be tried in wort.

Experiment solitary touching pilosity and plumage.

680. Beasts are more hairy than men, and savage men more

[1] Arist. Prob. ix. 1.

[2] There is of course no true conversion of muscular fibre or of albumen into fat. Bacon's error is similar to that of the chemists who, in the early part of the present century, were misled by the appearance of bodies exhumed from a cemetery at Paris into believing that under certain circumstances fat can be produced by the azotized elements of animal tissues. It was in this case also thought that the experiment would be "of profit;" but Gay-Lussac showed that the change observed was merely the result of a partial saponification of the already existing fat, due to the production of ammonia during decomposition. A company was formed in England for the manufacture of what was called *adipocire*, chiefly, I believe, from horse-flesh; but the project led to no result.

[3] Wine so prepared was called Thalassites. See Pliny, xiv. 11.

than civil; and the plumage of birds exceedeth the pilosity of beasts. The cause of the smoothness in men is not any abundance of heat and moisture, though that indeed causeth pilosity; but there is requisite to pilosity, not so much heat and moisture, as excrementitious heat and moisture; (for whatsoever assimilateth, goeth not into the hair;) and excrementitious moisture aboundeth most in beasts, and men that are more savage. Much the same reason is there of the plumage of birds, for birds assimilate less, and excern more than beasts: for their excrements are ever liquid, and their flesh (generally) more dry: besides, they have not instruments for urine; and so all the excrementitious moisture goeth into the feathers: and therefore it is no marvel though birds be commonly better meat than beasts, because their flesh doth assimilate more finely, and secerneth more subtilly. Again, the head of man hath hair upon the first birth, which no other part of the body hath. The cause may be want of perspiration; for much of the matter of hair, in the other parts of the body, goeth forth by insensible perspiration; and besides, the skull being of a more solid substance, nourisheth and assimilateth less, and excerneth more; and so likewise doth the chin. We see also that hair cometh not upon the palms of the hands, nor soles of the feet; which are parts more perspirable. And children likewise are not hairy, for that their skins are more perspirable.

Experiment solitary touching the quickness of motion in birds.

681. Birds are of swifter motion than beasts; for the flight of many birds is swifter than the race of any beasts. The cause is, for that the spirits in birds are in greater proportion, in comparison of the bulk of their body, than in beasts: for as for the reason that some give, that they are partly carried, whereas beasts go, that is nothing; for by that reason swimming should be swifter than running: and that kind of carriage also is not without labour of the wing.

Experiment solitary touching the different clearness of the sea.

682. The sea is clearer when the north wind bloweth, than when the south wind.[1] The cause is, for that salt water hath

[1] Aristotle, on the contrary, asserts that the sea is clearer with a south wind than with a north. See the Problems, xxvi. 39.

a little oiliness in the surface thereof, as appeareth in very hot days: and again, for that the southern wind relaxeth the water somewhat; as no water boiling is so clear as cold water.

Experiment solitary touching the different heats of fire and boiling water.

683. Fire burneth wood, making it first luminous, then black and brittle, and lastly broken and incinerate: scalding water doth none of these.[1] The cause is, for that by fire the spirit of the body is first refined, and then emitted; whereof the refining or attenuation causeth the light; and the emission, first the fragility, and after the dissolution into ashes; neither doth any other body enter: but in water the spirit of the body is not refined so much; and besides part of the water entereth, which doth increase the spirit, and in a degree extinguish it: therefore we see that hot water will quench fire. And again we see that in bodies wherein the water doth not much enter, but only the heat passeth, hot water worketh the effects of fire; as in eggs boiled and roasted (into which the water entereth not at all) there is scarce difference to be discerned[2]; but in fruit and flesh, whereinto the water entereth in some part, there is much more difference.

Experiment solitary touching the qualification of heat by moisture.

684. The bottom of a vessel of boiling water (as hath been observed) is not very much heated; so as men may put their hand under the vessel and remove it.[3] The cause is, for that the moisture of water, as it quencheth coals where it entereth, so it doth allay heat where it toucheth: and therefore note well, that moisture, although it doth not pass through bodies without communication of some substance (as heat and cold do), yet it worketh manifest effects; not by entrance of the body, but by qualifying of the heat and cold; as we see in this instance: and we see likewise that the water of things distilled in water (which they call the bath) differeth not much from the water of things distilled by fire. We see also that pewter

[1] Arist. Prob. xxiii. 3.

[2] Sir T. Brown has remarked that an egg loses weight by roasting, and not by boiling. That evaporation goes on through the shell is shown by the fact that eggs become lighter during incubation. In fact, according to St. Hilaire, if communication with the atmosphere is completely cut off, the development of the chick is prevented.

[3] Arist. Prob. xxiii. 5.

dishes with water in them will not melt easily; but without it they will; nay we see more, that butter or oil, which in themselves are inflammable, yet by the virtue of their moisture will do the like.

Experiment solitary touching yawning.

685. It hath been noted by the ancients, that it is dangerous to pick one's ear whilst he yawneth.[1] The cause is, for that in yawning the inner parchment of the ear is extended, by the drawing in of the spirit and breath[2]; for in yawning and sighing both, the spirit is first strongly drawn in, and then strongly expelled.

Experiment solitary touching the hiccough.

686. It hath been observed by the ancients, that sneezing doth cease the hiccough.[3] The cause is, for that the motion of the hiccough is a lifting up of the stomach; which sneezing doth somewhat depress, and divert the motion another way. For first we see that the hiccough cometh of fulness of meat (especially in children), which causeth an extension of the stomach: we see also it is caused by acid meats or drinks, which is by the pricking of the stomach; and this motion is ceased either by diversion, or by detention of the spirits; diversion, as in sneezing; detention, as we see holding of the breath doth help somewhat to cease the hiccough; and putting a man into an earnest study doth the like; as is commonly used: and vinegar put to the nostrils, or gargarised, doth it also; for that it is astringent, and inhibiteth the motion of the spirits.

Experiment solitary touching sneezing.

687. Looking against the sun doth induce sneezing.[4] The cause is not the heating of the nostrils; for then the holding up of the nostrils against the sun, though one wink, would do it; but the drawing down of the moisture of the brain; for it will make the eyes run with water: and the drawing of moisture to the eyes, doth draw it to the nostrils by motion of consent; and so followeth sneezing: as contrariwise, the tickling of the

[1] Arist. Prob. xxxii. 13.

[2] The drum is not directly distended, if at all, by the effort of yawning; but it is pressed on by the air forced into the Eustachian tubes. In man and the mammalia generally, the drum is slightly depressed inwards. It may therefore become convex during yawning, and thus more liable to come into contact with anything inserted into the ear.

[3] Arist. Prob. xxxiii. 1., and elsewhere.

[4] Id. ib. xxxiii. 4.

nostrils within, doth draw the moisture to the nostrils, and to the eyes by consent; for they also will water. But yet it hath been observed, that if one be about to sneeze, the rubbing of the eyes till they run with water will prevent it.[1] Whereof the cause is, for that the humour which was descending to the nostrils, is diverted to the eyes.

Experiment solitary touching the tenderness of the teeth.[2]

688. The teeth are more by cold drink or the like affected, than the other parts. The cause is double; the one, for that the resistance of bone to cold is greater than of flesh; for that the flesh shrinketh, but the bone resisteth, whereby the cold becometh more eager: the other is, for that the teeth are parts without blood; whereas blood helpeth to qualify the cold: and therefore we see that the sinews are much affected with cold, for that they are parts without blood; so the bones in sharp colds wax brittle: and therefore it hath been seen that all contusions of bones in hard weather are more difficult to cure.

Experiment solitary touching the tongue.

689. It hath been noted that the tongue receiveth more easily tokens of diseases, than the other parts; as of heats within, which appear most in the blackness of the tongue. Again, pyed cattle are spotted in their tongues, &c. The cause is (no doubt) the tenderness of the part; which thereby receiveth more easily all alterations, than any other parts of the flesh.

Experiment solitary touching the taste.

690. When the mouth is out of taste, it maketh things taste sometimes salt, chiefly bitter, and sometimes loathsome; but never sweet. The cause is, the corrupting of the moisture about the tongue, which many times turneth bitter, and salt, and loathsome; but sweet never: for the rest are degrees of corruption.

Experiment solitary touching some prognostics of pestilential seasons.

691. It was observed in the great plague of the last year, that there were seen, in divers ditches and low grounds about London, many toads that had tails two or three inches long at

[1] Arist. Prob. xxxiii. 8.

[2] See for the statements in this and the two next paragraphs Arist. Prob. xxxiv. 2, 3, 4, and 5.

the least; whereas toads (usually) have no tails at all.[1] Which argueth a great disposition to putrefaction in the soil and air. It is reported likewise, that roots (such as carrots and parsnips) are more sweet and luscious in infectious years than in other years.

Experiment solitary touching special simples for medicines.

692. Wise physicians should with all diligence inquire what simples nature yieldeth, that have extreme subtile parts, without any mordication or acrimony: for they undermine that which is hard, they open that which is stopped and shut, and they expel that which is offensive, gently, without too much perturbation. Of this kind are elder-flowers, which therefore are proper for the stone: of this kind is the dwarf-pine, which is proper for the jaundice: of this kind is hartshorn, which is proper for agues and infections: of this kind is piony, which is proper for stoppings in the head: of this kind is fumitory, which is proper for the spleen: and a number of others. Generally, divers creatures bred of putrefaction, though they be somewhat loathsome to take, are of this kind; as earth-worms, timber-sows, snails, &c. And I conceive that the trochischs of vipers, (which are so much magnified,) and the flesh of snakes some ways condited and corrected, (which of late are grown into some credit,) are of the same nature. So the parts of beasts putrefied (as castoreum and musk, which have extreme subtile parts,) are to be placed amongst them. We see also that putrefactions of plants (as agaric and Jew's-ear) are of greatest virtue. The cause is, for that putrefaction is the subtilest of all motions in the parts of bodies; and since we cannot take down the lives of living creatures, (which some of the Paracelsians say, if they could be taken down, would make us immortal,) the next is for subtilty of operation, to take bodies putrefied; such as may be safely taken.

Experiments in consort touching Venus.

693. It hath been observed by the ancients, that much use of Venus doth dim the sight; and yet eunuchs, which are unable

[1] But the tadpoles which become toads have; and it is possible that under certain circumstances the tails may not disappear until the limbs are sufficiently developed to make it doubtful whether the animal ought not to be called a toad. Milne Edwards has shown that tadpoles kept in the dark increase in size, but do not undergo the usual transformation. So many idle stories, however, are told in a time of general panic, that it is scarcely worth while to attempt to explain the statement in the text.

to generate, are nevertheless also dim-sighted.[1] The cause of dimness of sight in the former, is the expence of spirits; in the latter, the over-moisture of the brain; for the over-moisture of the brain doth thicken the spirits visual, and obstructeth their passages; as we see by the decay in the sight in age; where also the diminution of the spirits concurreth as another cause: we see also that blindness cometh by rheums and cataracts. Now in eunuchs there are all the notes of moisture; as the swelling of their thighs, the looseness of their belly, the smoothness of their skin, &c.

694. The pleasure in the act of Venus is the greatest of the pleasures of the senses: the matching of it with itch is unproper; though that also be pleasing to the touch.[2] But the causes are profound. First, all the organs of the senses qualify the motions of the spirits; and make so many several species of motions, and pleasures or displeasures thereupon, as there be diversities of organs. The instruments of sight, hearing, taste, and smell, are of several frame, and so are the parts for generation. Therefore Scaliger doth well to make the pleasure of generation a sixth sense[3]; and if there were any other differing organs, and qualified perforations for the spirits to pass, there would be more than the five senses: neither do we well know whether some beasts and birds have not senses that we know not: and the very scent of dogs is almost a sense by itself. Secondly, the pleasures of the touch are greater and deeper than those of the other senses; as we see in warming upon cold, or refrigeration upon heat; for as the pains of the touch are greater than the offences of other senses, so likewise are the pleasures. It is true, that the affecting of the spirits immediately, and (as it were) without an organ, is of the greatest pleasure; which is but in two things; sweet smells, and wine and the like sweet vapours. For smells, we see their great and sudden effect in fetching men again when they swoon: for drink, it is certain that the pleasure of drunkenness is next the pleasure of Venus; and great joys likewise make the spirits move and touch themselves: and the pleasure of Venus is somewhat of the same kind.

695. It hath been always observed that men are more in-

[1] Arist. Prob. iv. 3.
[2] Id. ib iv. 16.
[3] Scaliger, Adv. Cardan. 236. 3.

clined to Venus in the winter, and women in the summer.[1] The cause is, for that the spirits, in a body more hot and dry (as the spirits of men are), by the summer are more exhaled and dissipated; and in the winter more condensed, and kept entire: but in bodies that are cold and moist (as women's are), the summer doth cherish the spirits, and calleth them forth; the winter doth dull them. Furthermore, the abstinence or intermission of the use of Venus in moist and well habituate bodies, breedeth a number of diseases: and especially dangerous imposthumations. The reason is evident; for that it is a principal evacuation, especially of the spirits; for of the spirits there is scarce any evacuation, but in Venus and exercise. And therefore the omission of either of them breedeth all diseases of repletion.

Experiments in consort touching the insecta.

The nature of vivification is very worthy the inquiry: and as the nature of things is commonly better perceived in small than in great, and in unperfect than in perfect, and in parts than in whole; so the nature of vivification is best inquired in creatures bred of putrefaction. The contemplation whereof hath many excellent fruits. First, in disclosing the original of vivification. Secondly, in disclosing the original of figuration. Thirdly, in disclosing many things in the nature of perfect creatures, which in them lie more hidden. And fourthly, in traducing, by way of operation, some observations in the insecta, to work effects upon perfect creatures. Note, that the word *insecta* agreeth not with the matter, but we ever use it for brevity's sake, intending by it creatures bred of putrefaction.

696. The insecta are found to breed out of several matters: some breed of mud or dung; as the earth-worms, eels, snakes, &c. For they are both putrefactions: for water in mud doth putrefy, as not able to preserve itself: and for dung, all excrements are the refuse and putrefactions of nourishment. Some breed in wood, both growing and cut down. *Quære* in what woods most, and at what seasons? We see that the worms with many feet, which round themselves into balls, are bred

[1] Arist. Prob. iv. 26. and Hist. An. v. 8.

chiefly under logs of timber, but not in the timber; and they are said to be found also (many times) in gardens where no logs are. But it seemeth their generation requireth a coverture, both from sun and rain or dew; as the timber is; and therefore they are not venomous, but (contrariwise) are held by the physicians to clarify the blood. It is observed that cimices are found in the holes of bedsides. Some breed in the hair of living creatures, as lice and tikes; which are bred by the sweat close kept and somewhat arefied by the hair. The excrements of living creatures do not only breed insecta when they are excerned, but also while they are in the body; as in worms, whereto children are most subject, and are chiefly in the guts. And it hath been lately observed by physicians, that in many pestilent diseases there are worms found in the upper parts of the body, where excrements are not, but only humours putrefied. Fleas breed principally of straw or mats, where there hath been a little moisture; or the chamber and bedstraw kept close and not aired. It is received that they are killed by strewing wormwood in the rooms. And it is truly observed that bitter things are apt rather to kill, than engender putrefaction; and they be things that are fat or sweet that are aptest to putrefy. There is a worm that breedeth in meal, of the shape of a large white maggot, which is given as a great dainty to nightingales. The moth breedeth upon cloth and other lanifices; especially if they be laid up dankish and wet. It delighteth to be about the flame of a candle. There is a worm called a wevil, bred under ground, and that feedeth upon roots; as parsnips, carrots, &c. Some breed in waters, especially shaded, but they must be by standing waters; as the water-spider that hath six legs. The fly called the gad-fly, breedeth of somewhat that swimmeth upon the top of the water, and is most about ponds. There is a worm that breedeth of the dregs of wine decayed; which afterwards (as is observed by some of the ancients) turneth into a gnat. It hath been observed by the ancients, that there is a worm that breeds in old snow, and is of colour reddish, and dull of motion, and dieth soon after it cometh out of snow.[1] Which should shew, that snow hath in it a secret warmth; for else it could hardly vivify. And the reason of the dying of the worm, may be the sudden exhaling of that little spirit, as soon as it cometh out of the

[1] Arist. Hist. An. v. 19.

cold, which had shut it in. For as butterflies quicken with heat, which were benumbed with cold; so spirits may exhale with heat, which were preserved in cold. It is affirmed both by ancient and modern observation, that in furnaces of copper and brass where chalcites (which is vitriol) is often cast in to mend the working, there riseth suddenly a fly, which sometimes moveth as if it took hold on the walls of the furnace, sometimes is seen moving in the fire below; and dieth presently as soon as it is out of the furnace[1]: which is a noble instance, and worthy to be weighed; for it sheweth, that as well violent heat of fire as the gentle heat of living creatures will vivify, if it have matter proportionable. Now the great axiom of vivification is, that there must be heat to dilate the spirit of the body; an active spirit to be dilated; matter viscous or tenacious to hold in the spirit; and that matter to be put forth and figured. Now a spirit dilated by so ardent a fire as that of the furnace, as soon as ever it cooleth never so little, congealeth presently. And no doubt this action is furthered by the chalcites, which hath a spirit that will put forth and germinate, as we see in chemical trials. Briefly, most things putrefied bring forth insecta of several names; but we will not take upon us now to enumerate them all.

697. The insecta have been noted by the ancients to feed little: but this hath not been diligently observed; for grasshoppers eat up the green of whole countries; and silk-worms devour leaves swiftly; and ants make great provision. It is true, that creatures that sleep and rest much, eat little; as dormice and bats, &c. They are all without blood[2]: which may be, for that the juice of their bodies is almost all one; not blood, and flesh, and skin, and bone, as in perfect creatures; the integral parts have extreme variety, but the similar parts

[1] Arist. ubi supra.

[2] It has long been known that, contrary to the opinion of Aristotle, insects are not bloodless; and it now appears to be established, contrary to the opinion of as great a naturalist, that they possess a system of closed vessels which corresponds to the circulating system of other classes of animals. Cuvier's opinion that respiration by trachea is inconsistent with circulation in closed vessels must therefore be abandoned, if the results obtained by one or two Italian physiologists, and in France by Blanchard, are to be depended on. But the subject is confessedly obscure and difficult. There was perhaps in Cuvier, so difficult is it even for the greatest men absolutely to divest themselves of personal predilection, a tendency to underrate the position of the Articulata in the scale of creation, as compared with that of the Mollusca, whose complex organisation he was the first to demonstrate. It is curious to observe that St. Hilaire, in the controversy between him and Cuvier which took place in 1830, insists, with the manifest intention of annoying his opponent, that the Mollusca have properly speaking no brain.

little. It is true that they have (some of them) a diaphragm and an intestine; and they have all skins; which in most of the insecta are cast often. They are not generally of long life; yet bees have been known to live seven years: and snakes are thought, the rather for the casting of their spoil, to live till they be old: and eels, which many times breed of putrefaction, will live and grow very long: and those that interchange from worms to flies in the summer, and from flies to worms in the winter, have been kept in boxes four years at the least. Yet there are certain flies, that are called ephemera, that live but a day. The cause is the exility of the spirit; or perhaps the absence of the sun; for that if they were brought in, or kept close, they might live longer. Many of the insecta (as butterflies and other flies) revive easily when they seem dead, being brought to the sun or fire. The cause whereof is the diffusion of the vital spirit, and the easy dilating of it by a little heat. They stir a good while after their heads are off, or that they be cut in pieces; which is caused also, for that their vital spirits are more diffused throughout all their parts, and less confined to organs than in perfect creatures.

698. The insecta have voluntary motion, and therefore imagination; and whereas some of the ancients have said that their motion is indeterminate and their imagination indefinite, it is negligently observed; for ants go right forwards to their hills; and bees do (admirably) know the way from a flowery heath two or three miles off to their hives. It may be, gnats and flies have their imagination more mutable and giddy, as small birds likewise have. It is said by some of the ancients, that they have only the sense of feeling[1]; which is manifestly untrue; for if they go forth-right to a place, they must needs have sight[2]; besides they delight more in one flower or herb than in another, and therefore have taste: and bees are called with sound upon brass, and therefore they have hearing; which sheweth likewise, that though their spirit be diffused, yet there is a seat of their senses in their head.

[1] Aristotle, on the contrary, agrees with Bacon in thinking that insects possess all the senses, and gives much the same reasons. A curious proof of the existence of the sense of smell is that insects are deceived by the similarity of odours.

[2] The notion that the bee could only see a few inches before it, and consequently that its return to the same pasture was a proof of great memory, was founded upon an erroneous view of the nature of insect vision. The bee, like other insects, sees chiefly by means of a number of tubes, each pointed in its own direction, and each connected with a distinct nervous filament. There is therefore no assignable reason why it should not see as far as the stars. See Müller's Physiology.

Other observations concerning the insecta, together with the enumeration of them, we refer to that place where we mean to handle the title of animals in general.

Experiment solitary touching leaping.

699. A man leapeth better with weights in his hands than without.[1] The cause is, for that the weight (if it be proportionable) strengtheneth the sinews by contracting them. For otherwise, where no contraction is needful, weight hindereth; as we see in horse-races men are curious to foresee that there be not the least weight upon the one horse more than upon the other. In leaping with weights, the arms are first cast backwards, and then forwards with so much the greater force; for the hands go backward before they take their raise. *Quære*, if the contrary motion of the spirits, immediately before the motion we intend, doth not cause the spirits as it were to break forth with more force: as breath also drawn and kept in cometh forth more forcibly: and in casting of any thing, the arms, to make a greater swing, are first cast backward.

Experiment solitary touching the pleasures and displeasures of the senses, especially of hearing.

700. Of musical tones and unequal sounds we have spoken before; but touching the pleasure and displeasure of the senses, not so fully. Harsh sounds, as of a saw when it is sharpened; grinding of one stone against another; squeaking or skriching noise; make a shivering or horror in the body, and set the teeth on edge. The cause is, for that the objects of the ear do affect the spirits (immediately) most with pleasure and offence. We see there is no colour that affecteth the eye much with displeasure: there be sights that are horrible, because they excite the memory of things that are odious or fearful; but the same things painted do little affect. As for smells, tastes, and touches, they be things that do affect by a participation or impulsion of the body of the object. So it is sound alone that doth immediately and incorporeally affect most. This is most manifest in music, and concords and discords in music; for all sounds, whether they be sharp or flat, if they be sweet, have a roundness and equality; and if they be harsh, are unequal; for a discord itself is but a harshness of divers sounds meeting.

[1] Arist. Problem. v. 8.

It is true that inequality not stayed upon, but passing, is rather an increase of sweetness; as in the purling of a wreathed string; and in the raucity of a trumpet; and in the nightingale-pipe of a regal; and in a discord straight falling upon a concord: but if you stay upon it, it is offensive. And therefore there be these three degrees of pleasing and displeasing in sounds; sweet sounds; discords; and harsh sounds, which we call by divers names, as skriching or grating, such as we now speak of. As for the setting of the teeth on edge, we see plainly what an intercourse there is between the teeth and the organ of the hearing, by the taking of the end of a bow between the teeth, and striking upon the string.

NATURAL HISTORY.

CENTURY VIII.

Experiment solitary touching veins of medicinal earth.

701. THERE be minerals and fossils in great variety; but of veins of earth medicinal, but few; the chief are, Terra Lemnia[1], Terra Sigillata communis, and Bolus Arminus; whereof Terra Lemnia is the chief. The virtues of them are, for curing of wounds, stanching of blood, stopping of fluxes and rheums, and arresting the spreading of poison, infection, and putrefaction: and they have of all other simples the perfectest and purest quality of drying, with little or no mixture of any other quality. Yet it is true that the Bole-Arminic is the most cold of them, and that Terra Lemnia is the most hot; for which cause the island Lemnos, where it is digged, was in the old fabulous ages consecrated to Vulcan.

Experiment solitary touching the growth of spunges.

702. About the bottom of the Straits[2] are gathered great quantities of spunges, which are gathered from the sides of rocks, being as it were a large but tough moss. It is the more to be noted, because that there be but few substances, plant-like, that grow deep within the sea; for they are gathered sometimes fifteen fathom deep: and when they are laid on shore, they seem to be of great bulk; but crushed together, will be transported in a very small room.

[1] See, for some account of Terra Lemnia, Sandys's Travels, p. 18. (7th edition).
[2] That is, the Hellespont. See Sandys, p. 14.

Experiment solitary touching sea-fish put in fresh waters.

703. It seemeth that fish that are used to the salt water, do nevertheless delight more in fresh. We see that salmons and smelts love to get into rivers, though it be against the stream. At the haven of Constantinople you shall have great quantities of fish that come from the Euxine Sea; that when they come into the fresh water, do inebriate and turn up their bellies, so as you may take them with your hand.[1] I doubt there hath not been sufficient experiment made of putting sea-fish into fresh-water ponds and pools. It is a thing of great use and pleasure; for so you may have them new at some good distance from the sea: and besides, it may be, the fish will eat the pleasanter, and may fall to breed. And it is said, that Colchester oysters, which are put into pits where the sea goeth and cometh, (but yet so that there is a fresh water coming also to them when the sea voideth,) become by that means fatter and more grown.

Experiment solitary touching attraction by similitude of substance.

704. The Turkish bow giveth a very forcible shoot; insomuch as it hath been known that the arrow hath pierced a steel target, or a piece of brass of two inches thick: but that which is more strange, the arrow, if it be headed with wood, hath been known to pierce through a piece of wood of eight inches thick.[2] And it is certain that we had in use at one time, for sea-fight, short arrows, which they called sprights, without any other heads, save wood sharpened; which were discharged out of muskets, and would pierce through the sides of ships where a bullet would not pierce. But this dependeth upon one of the

[1] Sandys, p. 23. Modern experience has confirmed what Sandys here relates; but there is no reason to suppose that the fish have any enjoyment in the state of half insensibility which the change to fresh water produces. The cause is probably to be sought in what appears *à priori* to be certain,—namely, the rapid absorption through the gills of fresh water. All the conditions appear to be present by which absorption by endosmosis is occasioned. The periodical migrations from salt to fresh water, and *vice versa*, of certain kinds of fish may perhaps be connected with a change in the composition of the blood, determining endosmosis or exosmosis through the gills, and consequently rendering the fish uneasy in its actual position.

Has it ever been suggested that the persevering way in which salmon ascend rapid streams may result from the unequal velocity of the water at different depths? The consequence of this variation would be a sensation of greater pressure against the lower part of the body than on the upper; which under certain circumstances may be agreeable.

[2] Ll. p. 50.

greatest secrets in all nature; which is, that similitude of substance will cause attraction, where the body is wholly freed from the motion of gravity: for if that were taken away, lead would draw lead, and gold would draw gold, and iron would draw iron, without the help of the loadstone. But this same motion of weight or gravity (which is a mere motion of matter, and hath no affinity with the form or kind) doth kill the other motion, except itself be killed by a violent motion; as in these instances of arrows; for then the motion of attraction by similitude of substance beginneth to shew itself. But we shall handle this point of nature fully in due place.

Experiment solitary touching certain drinks in Turkey.

705. They have in Turkey and the East certain confections, which they call servets, which are like to candied conserves, and are made of sugar and lemons, or sugar and citrons, or sugar and violets, and some other flowers; and some mixture of amber for the more delicate persons: and those they dissolve in water, and thereof make their drink, because they are forbidden wine by their law.[1] But I do much marvel that no Englishman, or Dutchman, or German, doth set up brewing in Constantinople; considering they have such quantity of barley. For as for the general sort of men, frugality may be the cause of drinking water; for that it is no small saving to pay nothing for one's drink: but the better sort might well be at the cost. And yet I wonder the less at it, because I see France, Italy, or Spain, have not taken into use beer or ale: which (perhaps) if they did, would better both their healths and their complexions. It is likely it would be matter of great gain to any that should begin it in Turkey.

Experiments in consort touching sweat.[2]

706. In bathing in hot water, sweat nevertheless cometh not in the parts under the water. The cause is: first, for that sweat is a kind of colliquation, and that kind of colliquation is not made either by an over-dry heat, or an over-moist heat: for over-moisture doth somewhat extinguish the heat; as we

[1] Sandys, p. 51. He like Bacon suggests the establishment of breweries at Constantinople.

[2] For the statements in this and the next three paragraphs, see Arist. Prob. ii. 2, 3, 4. 16, and 23.

see that even hot water quencheth fire; and over-dry heat shutteth the pores: and therefore men will sooner sweat covered before the sun or fire, than if they stood naked: and earthen bottles filled with hot water do provoke, in bed, a sweat more daintily than brick-bats hot. Secondly, hot water doth cause evaporation from the skin; so as it spendeth the matter in those parts under the water, before it issueth in sweat. Again, sweat cometh more plentifully, if the heat be increased by degrees, than if it be greatest at first, or equal. The cause is, for that the pores are better opened by a gentle heat than by a more violent; and by their opening the sweat issueth more abundantly. And therefore physicians may do well, when they provoke sweat in bed by bottles with a decoction of sudorific herbs in hot water, to make two degrees of heat in the bottles; and to lay in the bed the less heated first, and after half an hour, the more heated.

707. Sweat is salt in taste; the cause is, for that that part of the nourishment which is fresh and sweet, turneth into blood and flesh; and the sweat is only that part which is separate and excerned. Blood also raw hath some saltness, more than flesh; because the assimilation into flesh is not without a little and subtile excretion from the blood.

708. Sweat cometh forth more out of the upper parts of the body than the lower; the reason is, because those parts are more replenished with spirits; and the spirits are they that put forth sweat: besides, they are less fleshy, and sweat issueth (chiefly) out of the parts that are less fleshy, and more dry; as the forehead and breast.

709. Men sweat more in sleep than waking; and yet sleep doth rather stay other fluxions, than cause them; as rheums, looseness of the body, &c. The cause is, for that in sleep the heat and spirits do naturally move inwards, and there rest. But when they are collected once within, the heat becometh more violent and irritate; and thereby expelleth sweat.

710. Cold sweats are (many times) mortal, and near death; and always ill, and suspected: as in great fears, hypochondriacal passions, &c. The cause is, for that cold sweats come by a relaxation or forsaking of the spirits, whereby the moisture of the body, which heat did keep firm in the parts, severeth and issueth out.

711. In those diseases which cannot be discharged by sweat,

sweat is ill, and rather to be stayed; as in diseases of the lungs, and fluxes of the belly: but in those diseases which are expelled by sweat, it easeth and lighteneth; as in agues, pestilences, &c. The cause is, for that sweat in the latter sort is partly critical, and sendeth forth the matter that offendeth; but in the former, it either proceedeth from the labour of the spirits, which sheweth them oppressed; or from motion of consent, when nature, not able to expel the disease where it is seated, moveth to an expulsion indifferent over all the body.

Experiment solitary touching the glow-worm.

712. The nature of the glow-worm is hitherto not well observed. Thus much we see; that they breed chiefly in the hottest months of summer; and that they breed not in champaign, but in bushes and hedges. Whereby it may be conceived that the spirit of them is very fine, and not to be refined but by summer heats: and again, that by reason of the fineness it doth easily exhale. In Italy, and the hotter countries, there is a fly they call *lucciole*, that shineth as the glow-worm doth; and it may be is the flying glow-worm. But that fly is chiefly upon fens and marshes. But yet the two former observations hold: for they are not seen but in the heat of summer; and sedge, or other green of the fens, give as good shade as bushes. It may be the glow-worms of the cold countries ripen not so far as to be winged.

Experiments in consort touching the impressions which the passions of the mind make upon the body.

713. The passions of the mind work upon the body the impressions following. Fear causeth paleness, trembling, the standing of the hair upright, starting, and skriching. The paleness is caused, for that the blood runneth inward to succour the heart. The trembling is caused, for that through the flight of the spirits inward, the outward parts are destituted, and not sustained. Standing upright of the hair is caused, for that by shutting of the pores of the skin, the hair that lieth aslope must needs rise. Starting is both an apprehension of the thing feared, (and in that kind it is a motion of shrinking,) and likewise an inquisition, in the beginning, what the matter should be, (and in that kind it is a motion of erection); and

therefore when a man would listen suddenly to any thing, he starteth; for the starting is an erection of the spirits to attend. Skriching is an appetite of expelling that which suddenly striketh the spirits: for it must be noted that many motions, though they be unprofitable to expel that which hurteth, yet they are offers of nature, and cause motions by consent; as in groaning or crying upon pain.

714. Grief and pain cause sighing, sobbing, groaning, screaming and roaring, tears, distorting of the face, grinding of the teeth, sweating. Sighing is caused by the drawing in of a greater quantity of breath to refresh the heart that laboureth; like a great draught when one is thirsty. Sobbing is the same thing stronger. Groaning, and screaming, and roaring, are caused by an appetite of expulsion, as hath been said: for when the spirits cannot expel the thing that hurteth, in their strife to do it, by motion of consent they expel the voice. And this is when the spirits yield, and give over to resist: for if one do constantly resist pain, he will not groan. Tears are caused by a contraction of the spirits of the brain; which contraction by consequence astringeth the moisture of the brain, and thereby sendeth tears into the eyes. And this contraction or compression causeth also wringing of the hands; for wringing is a gesture of expression of moisture. The distorting of the face is caused by a contention, first to bear and resist, and then to expel; which maketh the parts knit first, and afterwards open. Grinding of the teeth is caused likewise by a gathering and serring of the spirits together to resist; which maketh the teeth also to set hard one against another. Sweating is also a compound motion, by the labour of the spirits first to resist, and then to expel.

715. Joy causeth a cheerfulness and vigour in the eyes, singing, leaping, dancing, and sometimes tears. All these are the effects of the dilatation and coming forth of the spirits into the outward parts; which maketh them more lively and stirring. We know it hath been seen that excessive sudden joy hath caused present death, while the spirits did spread so much as they could not retire again. As for tears, they are the effects of compression of the moisture of the brain, upon dilatation of the spirits. For compression of the spirits worketh an expression of the moisture of the brain by consent, as hath been said in grief. But then in joy, it worketh it diversely;

viz. by propulsion of the moisture, when the spirits dilate and occupy more room.

716. Anger causeth paleness in some, and the going and coming of the colour in others: also trembling in some: swelling, foaming at the mouth, stamping, bending of the fist. Paleness, and going and coming of the colour, are caused by the burning of the spirits about the heart; which, to refresh themselves, call in more spirits from the outward parts. And if the paleness be alone, without sending forth the colour again, it is commonly joined with some fear; but in many there is no paleness at all, but contrariwise redness about the cheeks and gills; which is by the sending forth of the spirits in an appetite to revenge. Trembling in anger is likewise by a calling in of the spirits; and is commonly when anger is joined with fear. Swelling is caused, both by a dilatation of the spirits by over-heating, and by a liquefaction or boiling of the humours thereupon. Foaming at the mouth is from the same cause, being an ebullition. Stamping, and bending of the fist, are caused by an imagination of the act of revenge.

717. Light displeasure or dislike causeth shaking of the head, frowning, and knitting of the brows. These effects arise from the same causes that trembling and horror do; namely, from the retiring of the spirits, but in a less degree. For the shaking of the head is but a slow and definite trembling; and is a gesture of slight refusal; and we see also that a dislike causeth (often) that gesture of the hand which we use when we refuse a thing, or warn it away. The frowning and knitting of the brows is a gathering or serring of the spirits, to resist in some measure. And we see also this knitting of the brows will follow upon earnest studying or cogitation of any thing, though it be without dislike.

718. Shame causeth blushing, and casting down of the eyes. Blushing is the resort of blood to the face; which in the passion of shame is the part that laboureth most. And although the blushing will be seen in the whole breast if it be naked, yet that is but in passage to the face. As for the casting down of the eyes, it proceedeth of the reverence a man beareth to other men; whereby, when he is ashamed, he cannot endure to look firmly upon others: and we see that blushing and the casting down of the eyes both, are more when we come before many; *ore Pompeii quid mollius? nunquam non coram pluribus*

erubuit[1]: and likewise when we come before great or reverend persons.

719. Pity causeth sometimes tears; and a flexion or cast of the eye aside. Tears come from the same cause that they do in grief: for pity is but grief in another's behalf. The cast of the eye is a gesture of aversion, or lothness to behold the object of pity.

720. Wonder causeth astonishment, or an immoveable posture of the body; casting up of the eyes to heaven; and lifting up of the hands. For astonishment, it is caused by the fixing of the mind upon one object of cogitation, whereby it doth not spatiate and transcur, as it useth; for in wonder the spirits fly not, as in fear; but only settle, and are made less apt to move. As for the casting up of the eyes and lifting up of the hands, it is a kind of appeal to the Deity; which is the author, by power and providence, of strange wonders.

721. Laughing causeth a dilatation of the mouth and lips; a continued expulsion of the breath, with the loud noise, which maketh the interjection of laughing; shaking of the breast and sides; running of the eyes with water, if it be violent and continued. Wherein first it is to be understood, that laughing is scarce (properly) a passion, but hath his source from the intellect; for in laughing there ever precedeth a conceit of somewhat ridiculous; and therefore it is proper to man. Secondly, that the cause of laughing is but a light touch of the spirits, and not so deep an impression as in other passions. And therefore (that which hath no affinity with the passions of the mind) it is moved, and that in great vehemency, only by tickling some parts of the body: and we see that men even in a grieved state of mind, yet cannot sometimes forbear laughing. Thirdly, it is ever joined with some degree of delight: and therefore exhilaration hath some affinity with joy, though it be a much lighter motion: *res severa est verum gaudium.*[2] Fourthly, that the object of it is deformity, absurdity, shrewd turns, and the like. Now to speak of the causes of the effects before mentioned, whereunto these general notes give some light. For the dilatation of the mouth and lips, continued expulsion of the breath and voice, and shaking of the breast and sides, they proceed (all) from the dilatation of the spirits;

[1] Seneca, Ep. 11.

[2] Id. ib. 23.

especially being sudden. So likewise, the running of the eyes with water (as hath been formerly touched, where we spake of the tears of joy and grief) is an effect of dilatation of the spirits. And for suddenness, it is a great part of the matter: for we see, that any shrewd turn that lighteth upon another, or any deformity, &c. moveth laughter in the instant; which after a little time it doth not. So we cannot laugh at anything after it is stale, but whilst it is new: and even in tickling, if you tickle the sides and give warning, or give a hard or continued touch, it doth not move laughter so much.

722. Lust causeth a flagrancy in the eyes; and priapism. The cause of both these is, for that in lust the sight and the touch are the things desired; and therefore the spirits resort to those parts which are most affected. And note well in general, (for that great use may be made of the observation,) that evermore the spirits, in all passions, resort most to the parts that labour most, or are most affected. As in the last which hath been mentioned, they resort to the eyes and venereous parts: in fear and anger to the heart: in shame to the face: and in light dislikes to the head.

Experiments in consort touching drunkenness.

723. It hath been observed by the ancients, and is yet believed, that the sperm of drunken men is unfruitful.[1] The cause is, for that it is over-moistened, and wanteth spissitude: and we have a merry saying, that they that go drunk to bed get daughters.

724. Drunken men are taken with a plain defect or destitution in voluntary motion. They reel; they tremble; they cannot stand, nor speak strongly. The cause is, for that the spirits of the wine oppress the spirits animal, and occupate part of the place where they are; and so make them weak to move. And therefore drunken men are apt to fall asleep: and opiates and stupefactives (as poppy, henbane, hemlock, &c.) induce a kind of drunkenness, by the grossness of their vapour; as wine doth by the quantity of the vapour. Besides, they rob the spirits animal of their matter, whereby they are nourished: for the spirits of the wine prey upon it as well as they: and so they make the spirits less supple and apt to move.

[1] For this and most of the statements in the next three paragraphs, see Arist. Prob. iii. 4, 5, 9, 10, and 12.

725. Drunken men imagine every thing turneth round; they imagine also that things come upon them; they see not well things afar off; those things that they see near hand they see out of their place; and (sometimes) they see things double. The cause of the imagination that things turn round is, for that the spirits themselves turn, being compressed by the vapour of the wine (for any liquid body upon compression turneth, as we see in water); and it is all one to the sight, whether the visual spirits move, or the object moveth, or the medium moveth. And we see that long turning round breedeth the same imagination. The cause of the imagination that things come upon them is, for that the spirits visual themselves draw back; which maketh the object seem to come on; and besides, when they see things turn round and move, fear maketh them think they come upon them. The cause that they cannot see things afar off, is the weakness of the spirits; for in every megrim or vertigo there is an obtenebration joined with a semblance of turning round; which we see also in the lighter sort of swoonings. The cause of seeing things out of their place, is the refraction of the spirits visual: for the vapour is an unequal medium; and it is as the sight of things out of place in water. The cause of seeing things double, is the swift and unquiet motion of the spirits (being oppressed) to and fro; for (as was said before) the motion of the spirits visual, and the motion of the object, make the same appearances: and for the swift motion of the object, we see that if you fillip a lute-string, it sheweth double or treble.

726. Men are sooner drunk with small draughts than with great. And again, wine sugared inebriateth less than wine pure. The cause of the former is, for that the wine descendeth not so fast to the bottom of the stomach, but maketh longer stay in the upper part of the stomach, and sendeth vapours faster to the head; and therefore inebriateth sooner. And for the same reason, sops in wine (quantity for quantity) inebriate more than wine of itself. The cause of the latter is, for that the sugar doth inspissate the spirits of the wine, and maketh them not so easy to resolve into vapour. Nay further, it is thought to be some remedy against inebriating, if wine sugared be taken after wine pure. And the same effect is wrought either by oil or milk, taken upon much drinking.

Experiment solitary touching the help or hurt of wine, though moderately used.

727. The use of wine in dry and consumed bodies is hurtful; in moist and full bodies it is good. The cause is, for that the spirits of the wine do prey upon the dew or radical moisture (as they term it) of the body, and so deceive the animal spirits. But where there is moisture enough, or superfluous, there wine helpeth to digest and desiccate the moisture.

Experiment solitary touching caterpillars.

728. The caterpillar is one of the most general of worms, and breedeth of dew and leaves; for we see infinite number of caterpillars which breed upon trees and hedges, by which the leaves of the trees or hedges are in great part consumed; as well by their breeding out of the leaf, as by their feeding upon the leaf. They breed in the spring chiefly, because then there is both dew and leaf. And they breed commonly when the east winds have much blown; the cause whereof is, the dryness of that wind; for to all vivification upon putrefaction, it is requisite the matter be not too moist: and therefore we see they have cobwebs about them, which is a sign of a slimy dryness; as we see upon the ground, whereupon, by dew and sun, cobwebs breed all over. We see also the green caterpillar breedeth in the inward parts of roses, especially not blown, where the dew sticketh; but especially caterpillars, both the greatest and the most, breed upon cabbages, which have a fat leaf, and apt to putrefy. The caterpillar, towards the end of summer, waxeth volatile, and turneth to a butterfly, or perhaps some other fly. There is a caterpillar that hath a fur or down upon him, and seemeth to have affinity with the silk-worm.

Experiment solitary touching the flies cantharides.

729. The flies cantharides are bred of a worm or caterpillar, but peculiar to certain fruit-trees; as are the fig-tree, the pine-tree, and the wild briar; all which bear sweet fruit, and fruit that hath a kind of secret biting or sharpness: for the fig hath a milk in it that is sweet and corrosive; the pine-apple hath a kernel that is strong and abstersive: the fruit of the briar is said to make children, or those that eat them, scabbed. And therefore no marvel though cantharides have such a corrosive

and cauterising quality[1]; for there is not any other of the insects, but is bred of a duller matter. The body of the cantharides is bright coloured; and it may be, that the delicate coloured dragon-flies may have likewise some corrosive quality.

Experiments in consort touching lassitude.

730. Lassitude is remedied by bathing, or anointing with oil and warm water.[2] The cause is, for that all lassitude is a kind of contusion and compression of the parts; and bathing and anointing give a relaxation or emollition; and the mixture of oil and water is better than either of them alone; because water entereth better into the pores, and oil after entry softeneth better. It is found also, that the taking of tobacco doth help and discharge lassitude. The reason whereof is, partly because by cheering or comforting of the spirits, it openeth the parts compressed or contused; and chiefly because it refresheth the spirits by the opiate virtue thereof, and so dischargeth weariness; as sleep likewise doth.

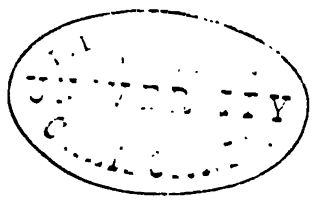
731. In going up a hill, the knees will be most weary; in going down a hill, the thighs.[3] The cause is, for that in the lift of the feet, when a man goeth up the hill, the weight of the body beareth most upon the knees; and in going down the hill, upon the thighs.

Experiment solitary touching the casting of the skin and shell in some creatures.

732. The casting of the skin is by the ancients compared to the breaking of the secundine, or caul[4]; but not rightly: for that were to make every casting of the skin a new birth: and

[1] All the species of the genus Cantharis, if not all the family of which this genus is the type, appear to have more or less the power of irritating the skin. The one commonly employed, namely Cantharis vesicatoria, seems to be preferred chiefly because on account of its gregarious habits it is more easily obtained. That it is only found on fruit-trees is an error. It is worth remarking, that by pine-apple Bacon means the cone of a pine. The name was transferred to the fruit of the Anana, in consequence of the resemblance the latter bears to a fir-cone.

[2] Arist. Prob. v. 6. So Pindar, Nem. iv.:



"Αριστος εὐφροσύνα
πόνων κεκριμένων
ἰατρός· αἱ δὲ σοφαὶ
Μοισᾶν ξυγατέρες δοιδαὶ
θέλξαν νιν ἀπτόμεναι.
Οὐδὲ θερμὸν ὕδωρ τόσον
γε μαλθακὰ τεύχει
γυῖα, τόσσων εὐλογία φόρ-
μιγγι συνόδορος.

[3] Id. ib. v. 19.

[4] Arist. Hist. Anim. viii. 17.

besides, the secundine is but a general cover, not shaped according to the parts; but the skin is shaped according to the parts. The creatures that cast their skin are, the snake, the viper, the grasshopper, the lizard, the silk-worm, &c. Those that cast their shell are, the lobster, the crab, the cra-fish, the hodmandod[1] or dodman, the tortoise, &c. The old skins are found, but the old shells never: so as it is like they scale off and crumble away by degrees. And they are known by the extreme tenderness and softness of the new shell, and sometimes by the freshness of the colour of it. The cause of the casting of skin and shell should seem to be, the great quantity of matter in those creatures that is fit to make skin or shell; and again, the looseness of the skin or shell, that sticketh not close to the flesh. For it is certain that it is the new skin or shell that putteth off the old: so we see that in deer it is the young horn that putteth off the old; and in birds, the young feathers put off the old: and so birds that have much matter for their beak, cast their beaks; the new beak putting off the old.

Experiments in consort touching the postures of the body.[2]

733. Lying not erect but hollow, which is in the making of the bed, or with the legs gathered up, which is in the posture of the body, is the more wholesome. The reason is, the better comforting of the stomach, which is by that less pensile: and we see that in weak stomachs, the laying up of the legs high, and the knees almost to the mouth, helpeth and comforteth. We see also that galley-slaves, notwithstanding their misery otherwise, are commonly fat and fleshy; and the reason is, because the stomach is supported somewhat in sitting, and is pensile in standing or going. And therefore, for prolongation of life, it is good to choose those exercises where the limbs move more than the stomach and belly; as in rowing, and in sawing being set.

734. Megrims and giddiness are rather when we rise after

[1] Shell snail. But of course neither they nor tortoises change their shells. It would be endless to point out all similar inaccuracies. Thus, a little further on, it is said that in deer the new horn puts off the old, whereas it is quite clear that the growth of the new horn does not begin until the old one is shed; it goes on, in fact, under the skin which some time afterwards forms over what may be called the stump. This is sufficiently obvious; but there is probably an equal error, though not so easily detected, in what is said with respect to feathers. The truth is, that the habit of close observation of common phenomena does not appear to have been much developed by Bacon's way of life.

[2] Compare Arist. Prob. vi. 3, 4, and 6.

long sitting, than while we sit. The cause is, for that the vapours, which were gathered by sitting, by the sudden motion fly more up into the head.

735. Leaning long upon any part maketh it numb, and, as we call it, asleep. The cause is, for that the compression of the part suffereth not the spirits to have free access; and therefore when we come out of it, we feel a stinging or pricking; which is the re-entrance of the spirits.

Experiment solitary touching pestilential years.

736. It hath been noted that those years are pestilential and unwholesome, when there are great numbers of frogs[1], flies, locusts, &c. The cause is plain; for that those creatures being engendered of putrefaction, when they abound, shew a general disposition of the year, and constitution of the air, to diseases of putrefaction. And the same prognostic (as hath been said before) holdeth, if you find worms in oak-apples: for the constitution of the air appeareth more subtilly in any of these things, than to the sense of man.

Experiment solitary touching the prognostics of hard winters.

737. It is an observation amongst country people, that years of store of haws and heps do commonly portend cold winters; and they ascribe it to God's providence, that (as the Scripture saith) reacheth even to the falling of a sparrow; and much more is like to reach to the preservation of birds in such seasons. The natural cause also may be the want of heat, and abundance of moisture, in the summer precedent; which putteth forth those fruits, and must needs leave great quantity of cold vapours not dissipate; which causeth the cold of the winter following.

Experiment solitary touching medicines that condense and relieve the spirits.

738. They have in Turkey a drink called *coffa*[2], made of a berry of the same name, as black as soot, and of a strong scent,

[1] Arist. Prob. i. 22.

[2] Sandys, p. 52. The use of coffee was, when Bacon wrote, of comparatively recent introduction at Constantinople. According to Abd el Kadir ibn Mahommed (ap. Silvestre de Sacy, Chrestomathie Arabe), who wrote in the 16th century, it has been used from all antiquity in Abyssinia, and passed from thence into Aden about the beginning of the 14th century. From Aden it spread gradually over the Mahommedan world, and reached Constantinople about the middle of the 16th century. I believe the first scientific description of the coffee plant is that given by Jussieu, in the Memoirs of the Academy of Sciences for 1713.

but not aromatical; which they take, beaten into powder, in water, as hot as they can drink it: and they take it, and sit at it in their coffa-houses, which are like our taverns. This drink comforteth the brain and heart, and helpeth digestion. Certainly this berry coffa, the root and leaf betel, the leaf tobacco, and the tear of poppy (opium), of which the Turks are great takers (supposing it expelleth all fear), do all condense the spirits, and make them strong and aleger. But it seemeth they were taken after several manners; for coffa and opium are taken down, tobacco but in smoke, and betel is but champed in the mouth with a little lime. It is like there are more of them, if they were well found out, and well corrected. *Quære* of henbane-seed; of mandrake; of saffron, root and flower; of folium indum; of ambergrise; of the Assyrian amomum, if it may be had; and of the scarlet powder which they call *kermez;* and (generally) of all such things as do inebriate and provoke sleep. Note that tobacco is not taken in root or seed, which are more forcible ever than leaves.

Experiment solitary touching paintings of the body.

739. The Turks have a black powder, made of a mineral called *alcohole,* which with a fine long pencil they lay under their eye-lids; which doth colour them black; whereby the white of the eye is set off more white.[1] With the same powder they colour also the hairs of their eye-lids, and of their eye-brows, which they draw into embowed arches. You shall find that Xenophon maketh mention, that the Medes used to paint their eyes. The Turks use with the same tincture to colour the hair of their heads and beards black. And divers with us that are grown grey, and yet would appear young, find means to make their hair black, by combing it (as they say) with a leaden comb, or the like. As for the Chineses, who are of an ill complexion (being olivaster), they paint their cheeks scarlet, especially their king and grandes.[2] Generally,

[1] Sandys, p. 53.

[2] I do not know where Bacon found this. It is not mentioned, I think, by modern travellers. The Chinese call us red men. It appears from Pliny, xxxiii. 36., that in early times it was usual in Rome to colour the image of Jupiter red, or at least its face, and to smear in a similar way the bodies of those who triumphed. O. K. Müller connects the two things, regarding the triumph as a kind of Apotheosis.

[I have retained the original spelling of *grandes;* the double *e,* which was no doubt introduced merely to mark the word as a dissyllable, has led to the misplacing of the accent. The Spanish *grande* would not have changed into the English *grande'e,* as we now pronounce it, except through ignorance. —*J. S.*]

barbarous people, that go naked, do not only paint themselves, but they pounce and raze their skin, that the painting may not be taken forth; and make it into works. So do the West Indians; and so did the ancient Picts and Britons; so that it seemeth men would have the colours of birds' feathers, if they could tell how; or at least they will have gay skins instead of gay clothes.

Experiment solitary touching the use of bathing and anointing.

740. It is strange that the use of bathing, as a part of diet, is left. With the Romans and Grecians it was as usual as eating or sleeping; and so is it amongst the Turks at this day: whereas with us it remaineth but as a part of physic. I am of opinion, that the use of it, as it was with the Romans, was hurtful to health; for that it made the body soft, and easy to waste. For the Turks it is more proper, because that their drinking water, and feeding upon rice, and other food of small nourishment, maketh their bodies so solid and hard, as you need not fear that bathing should make them frothy. Besides the Turks are great sitters, and seldom walk, whereby they sweat less and need bathing more. But yet certain it is that bathing, and especially anointing, may be so used as it may be a great help to health and prolongation of life. But hereof we shall speak in due place, when we come to handle experiments medicinal.

Experiment solitary touching chamoletting of paper.

741. The Turks have a pretty art of chamoletting of paper, which is not with us in use.[1] They take divers oiled colours, and put them severally (in drops) upon water; and stir the water lightly; and then wet their paper (being of some thickness) with it; and the paper will be waved and veined, like chamolet or marble.

Experiment solitary touching cuttle-ink.

742. It is somewhat strange, that the blood of all birds and beasts and fishes should be of a red colour, and only the blood of the cuttle should be as black as ink.[2] A man would think,

[1] Sandys, p. 56. Beckmann, in speaking of the invention of this art, mentions the passage in the text; but not being aware of the source of Bacon's information, asserts that notwithstanding the name Turkish paper, by which what is now called marbled paper used to be known, the art of making it was discovered in Germany.

[2] That the black fluid of the cuttle-fish is not blood was remarked by Aristotle,

that the cause should be the high concoction of that blood; for we see in ordinary puddings that the boiling turneth the blood to be black; and the cuttle is accounted a delicate meat, and is much in request.

Experiment solitary touching increase of weight in earth.

743. It is reported of credit, that if you take earth from land adjoining to the river of Nile, and preserve it in that manner that it neither come to be wet nor wasted, and weigh it daily, it will not alter weight until the seventeenth of June, which is the day when the river beginneth to rise: and then it will grow more and more ponderous, till the river cometh to his height.[1] Which if it be true, it cannot be caused but by the air, which then beginneth to condense; and so turneth within that small mould into a degree of moisture, which produceth weight. So it hath been observed that tobacco, cut and weighed, and then dried by the fire, loseth weight; and after being laid in the open air, recovereth weight again. And it should seem that as soon as ever the river beginneth to increase, the whole body of the air thereabouts suffereth a change: for (that which is more strange) it is credibly affirmed, that upon that very day when the river first riseth, great plagues in Cairo use suddenly to break up.

Experiments in consort touching sleep.

744. Those that are very cold, and especially in their feet, cannot get to sleep.[2] The cause may be, for that in sleep is required a free respiration, which cold doth shut in and hinder: for we see that in great colds one can scarce draw his breath. Another cause may be, for that cold calleth the spirits to succour; and therefore they cannot so well close and go together in the head; which is ever requisite to sleep. And for the same cause, pain and noise hinder sleep; and darkness (contrariwise) furthereth sleep.

745. Some noises (whereof we spake in the hundred and twelfth experiment) help sleep; as the blowing of the wind, the trickling of water, humming of bees, soft singing, reading,

Hist. An. i. 4. The blood of the Invertebrata is most frequently colourless. It is in some cases red, and often of other colours. The house fly is commonly believed to have red blood, but the red stain produced when a fly is crushed is in reality due to the pigment of the eyes.

[1] Sandys, p. 77.

[2] Arist. Prob. viii. 2.

&c. The cause is, for that they move in the spirits a gentle attention; and whatsoever moveth attention, without too much labour, stilleth the natural and discursive motion of the spirits.

746. Sleep nourisheth or at least preserveth bodies a long time, without other nourishment. Beasts that sleep in winter (as it is noted in wild bears) during their sleep wax very fat, though they eat nothing. Bats have been found in ovens, and other hollow close places, matted one upon another: and therefore it is likely that they sleep in the winter time and eat nothing. *Quære*, whether bees do not sleep all winter, and spare their honey? Butterflies, and other flies, do not only sleep, but lie as dead all winter; and yet with a little heat of sun or fire revive again. A dormouse, both winter and summer, will sleep some days together, and eat nothing.

Experiments in consort touching teeth and hard substances in the bodies of living creatures.

To restore teeth in age, were *magnale naturæ*. It may be thought of. But howsoever the nature of the teeth deserveth to be inquired of, as well as the other parts of living creatures' bodies.

747. There be five parts in the bodies of living creatures, that are of hard substance; the skull, the teeth, the bones, the horns, and the nails. The greatest quantity of hard substance continued is towards the head. For there is the skull, of one entire bone; there are the teeth; there are the maxillary bones; there is the hard bone that is the instrument of hearing; and thence issue the horns; so that the building of living creatures' bodies is like the building of a timber house; where the walls and other parts have columns and beams, but the roof is, in the better sort of houses, all tile or lead or stone. As for birds, they have three other hard substances proper to them; the bill, which is of the like matter with the teeth; for no birds have teeth: the shell of the egg: and their quills: for as for their spur, it is but a nail. But no living creatures that have shells very hard (as oysters, cockles, mussles, scallops, crabs, lobsters, cra-fish, shrimps, and especially the tortoise,) have bones within them, but only little gristles.[1]

[1] Here, as in 732., we see that Bacon knew but little of the natural history of the tortoise.

748. Bones, after full growth, continue at a stay; and so doth the skull: horns, in some creatures, are cast and renewed: teeth stand at a stay, except their wearing: as for nails, they grow continually: and bills and beaks will overgrow, and sometimes be cast; as in eagles and parrots.[1]

749. Most of the hard substances fly to the extremes of the body; as skull, horns, teeth, nails, and beaks: only the bones are more inward, and clad with flesh. As for the entrails, they are all without bones; save that a bone is (sometimes) found in the heart of a stag; and it may be in some other creature.

750. The skull hath brains, as a kind of marrow, within it. The back-bone hath one kind of marrow, which hath an affinity with the brain; and other bones of the body have another.[2] The jaw-bones have no marrow severed, but a little pulp of marrow diffused. Teeth likewise are thought to have a kind of marrow diffused, which causeth the sense and pain; but it is rather sinew: for marrow hath no sense; no more than blood. Horn is alike throughout; and so is the nail.

751. None other of the hard substances have sense, but the teeth; and the teeth have sense, not only of pain, but of cold.

But we will leave the inquiries of other hard substances unto their several places, and now inquire only of the teeth.

752. The teeth are, in men, of three kinds: sharp, as the fore-teeth; broad, as the back-teeth, which we call the molar-teeth, or grinders; and pointed teeth, or canine, which are between both.[3] But there have been some men that have had their teeth undivided, as of one whole bone, with some little mark in the place of the division, as Pyrrhus had.[4] Some creatures have over-long or out-growing teeth, which we call fangs, or tusks: as boars, pikes, salmons; and dogs, though less. Some living creatures have teeth against teeth, as men and horses; and some have teeth, especially their master-teeth,

[1] Bones, like the soft parts of the body, are renewed throughout life, and so in many cases are teeth. Cuvier has remarked that the mutual adaptation of teeth and the bones with which they are connected is one of the most admirable parts of the animal economy; the mode of development of the two structures being wholly dissimilar, teeth growing by secretion, and bones by intus-susception. V. Cuv. *Eloge de Tenon.*

[2] The marrow of bones is, of course, quite of a different nature from either brain or the spinal cord.

[3] This sentence is copied from Aristotle, *De Part. Anim.* iii. 1.

[4] Plutarch, in Pyrrhus, p. 434.

indented one within another like saws; as lions; and so again have dogs. Some fishes have divers rows of teeth in the roofs of their mouths; as pikes, salmons, trouts, &c. And many more in salt-waters. Snakes and other serpents have venomous teeth; which are sometimes mistaken for their sting.

753. No beast that hath horns hath upper teeth; and no beast that hath teeth above wanteth them below: but yet if they be of the same kind, it followeth not that if the hard matter goeth not into upper teeth, it will go into horns; nor yet *è converso;* for does, that have no horns, have no upper teeth.[1]

754 Horses have, at three years old, a tooth put forth, which they call the colt's tooth; and at four years' old there cometh the mark-tooth, which hath a hole as big as you may lay a pea[2] within it; and that weareth shorter and shorter every year; till that at eight years' old the tooth is smooth, and the hole gone: and then they say, that *the mark is out of the horse's mouth.*

755. The teeth of men breed first, when the child is about a year and a half old: and then they cast them, and new come about seven years' old. But divers have backward teeth come forth at twenty, yea, some at thirty and forty. *Quære* of the manner of the coming of them forth. They tell a tale of the old Countess of Desmond, who lived till she was seven score years old, that she did *dentire* twice or thrice; casting her old teeth, and others coming in their place.

756. Teeth are much hurt by sweetmeats; and by painting with mercury; and by things over-hot; and by things over-cold; and by rheums. And the pain of the teeth is one of the sharpest of pains.

757. Concerning teeth, these things are to be considered. 1. The preserving of them. 2. The keeping of them white. 3. The drawing of them with least pain. 4. The staying and easing of the toothache. 5. The binding in of artificial teeth, where teeth have been strucken out. 6. And last of all, that great one of restoring teeth in age. The instances that give any likelihood of restoring teeth in age are, the late coming of teeth in some; and the renewing of the beaks in birds, which are commaterial with teeth. *Quære* therefore more particularly how that cometh. And again, the renewing of horns.

[1] See Arist. De Part. Anim. iii. 2., and Hist. Animal. ii. 1.
[2] *a peuse* in the original.—*J. S.*

But yet that hath not been known to have been provoked by art; therefore let trial be made whether horns may be procured to grow in beasts that are not horned, and how? And whether they may be procured to come larger than usual; as to make an ox or a deer have a greater head of horns? And whether the head of a deer, that by age is more spitted, may be brought again to be more branched? for these trials, and the like, will show, whether by art such hard matter can be called and provoked. It may be tried also whether birds may not have something done to them when they are young, whereby they may be made to have greater or longer bills, or greater and longer talons? And whether children may not have some wash or something to make their teeth better and stronger? Coral is in use as an help to the teeth of children.

Experiments in consort touching the generation and bearing of living creatures in the womb.

758. Some living creatures generate but at certain seasons of the year; as deer, sheep, wild coneys, &c., and most sorts of birds and fishes: others at any time of the year; as men, and all domestic creatures, as horses, hogs, dogs, cats, &c.[1] The cause of generation at all seasons seemeth to be fulness: for generation is from redundance. This fulness ariseth from two causes: either from the nature of the creature, if it be hot and moist and sanguine; or from plenty of food. For the first, men, horses, dogs, &c. which breed at all seasons, are full of heat and moisture; doves are the fullest of heat and moisture amongst birds, and therefore breed often; the tame dove almost continually. But deer are a melancholy dry creature, as appeareth by their fearfulness, and the hardness of their flesh. Sheep are a cold creature, as appeareth by their mildness, and for that they seldom drink. Most sort of birds are of a dry substance in comparison of beasts. Fishes are cold. For the second cause, fulness of food; men, kine, swine, dogs, &c. feed full; and we see that those creatures which being wild generate seldom, being tame generate often; which is from warmth, and fulness of food. We find that the time of going to rut of deer is in September; for that they need the whole summer's feed and grass, to make them fit for generation. And if rain come early about the middle of September, they go to

[1] Arist. Prob. x. 49.

rut somewhat the sooner; if drought, somewhat the later. So sheep, in respect of their small heat, generate about the same time, or somewhat before. But for the most part, creatures that generate at certain seasons, generate in the spring; as birds and fishes; for that the end of the winter, and the heat and comfort of the spring, prepareth them. There is also another reason why some creatures generate at certain seasons: and that is the relation of their time of bearing to the time of generation; for no creature goeth to generate whilst the female is full; nor whilst she is busy in sitting, or rearing her young. And therefore it is found by experience, that if you take the eggs or young ones out of the nests of birds, they will fall to generate again, three or four times, one after another.

759. Of living creatures, some are longer time in the womb, and some shorter. Women go commonly nine months; the cow and the ewe about six months[1]; does go about nine months; mares eleven months; bitches nine weeks; elephants are said to go two years; for the received tradition of ten years is fabulous. For birds there is double inquiry: the distance between the treading or coupling, and the laying of the egg; and again, between the egg laid, and the disclosing or hatching: and amongst birds there is less diversity of time than amongst other creatures; yet some there is; for the hen sitteth but three weeks; the turkey-hen, goose, and duck, a month: *Quære* of others.[2] The cause of the great difference of times amongst living creatures, is either from the nature of the kind, or from the constitution of the womb. For the former, those that are longer in coming to their maturity or growth are longer in the womb; as is chiefly seen in men: and so elephants, which are long in the womb, are long time in coming to their full growth. But in most other kinds, the constitution of the womb (that is, the hardness or dryness thereof,) is concurrent with the former cause. For the colt hath about four years of growth; and so the fawn; and so the calf. But whelps, which come to their growth (commonly) within three quarters of a year, are but nine weeks in the womb. As for birds, as there is less diversity amongst them in the time of their bringing forth, so there is less

[1] These statements are very inaccurate. Tessier assigns 282 days in the former case, and 151 in the latter, as mean periods. See *Mém. de l'Ac. des Sciences*, (1817).

[2] The pigeon sits about eighteen days, the swan about thirty-three. The turkey-hen about twenty-seven, the duck and goose thirty to thirty-two days. The hen, as Bacon says, about three weeks. See Tessier and F. Cuvier, ubi supra.

diversity in the time of their growth; most of them coming to their growth within a twelvemonth.

760. Some creatures bring forth many young ones at a burthen: as bitches, hares, coneys, &c. Some (ordinarily) but one; as women, lionesses, &c.[1] This may be caused, either by the quantity of sperm required to the producing one of that kind; which if less be required, may admit greater number; if more, fewer: or by the partitions and cells of the womb, which may sever the sperm.

Experiments in consort touching species visible.

761. There is no doubt but light by refraction will shew greater, as well as things coloured. For like as a shilling in the bottom of the water will shew greater; so will a candle in a lanthorn, in the bottom of the water. I have heard of a practice, that glow-worms in glasses were put in the water to make the fish come. But I am not yet informed whether when a diver diveth, having his eyes open, and swimmeth upon his back; whether (I say) he seeth things in the air greater or less. For it is manifest that when the eye standeth in the finer medium, and the object is in the grosser, things shew greater; but contrariwise, when the eye is placed in the grosser medium, and the object in the finer, how it worketh I know not.

762. It would be well bolted out, whether great refractions may not be made upon reflexions, as well as upon direct beams. For example, we see that, take an empty bason, put an angel of gold, or what you will, into it; then go so far from the bason, till you cannot see the angel, because it is not in a right line; then fill the bason with water; and you shall see it out of his place, because of the reflexion. To proceed therefore, put a looking-glass into a bason of water; I suppose you shall not see the image in a right line, or at equal angles, but aside. I know not whether this experiment may not be extended so as you might see the image, and not the glass; which for beauty and strangeness were a fine proof: for then you should see the image like a spirit in the air. As for example, if there be a cistern or pool of water, you shall place over against it a picture of the devil, or what you will, so as you do not see the water. Then put a looking-glass in the water: now if you

[1] Arist. Prob. x. 16.

can see the devil's picture aside, not seeing the water, it will look like a devil indeed. They have an old tale in Oxford, that Friar Bacon walked between two steeples: which was thought to be done by glasses, when he walked upon the ground.

Experiments in consort touching impulsion and percussion.

763. A weighty body put into motion is more easily impelled, than at first when it resteth.[1] The cause is partly because motion doth discuss the torpor of solid bodies; which, beside their motion of gravity, have in them a natural appetite not to move at all; and partly because a body that resteth doth get, by the resistance of the body upon which it resteth, a stronger compression of parts than it hath of itself: and therefore needeth more force to be put in motion. For if a weighty body be pensile, and hang but by a thread, the percussion will make an impulsion very near as easily as if it were already in motion.

764. A body over-great or over-small, will not be thrown so far as a body of a middle size[2]: so that (it seemeth) there must be a commensuration or proportion between the body moved and the force, to make it move well. The cause is, because to the impulsion there is requisite the force of the body that moveth, and the resistance of the body that is moved: and if the body be too great, it yieldeth too little; and if it be too small, it resisteth too little.

765. It is common experience, that no weight will press or cut so strong, being laid upon a body, as falling or strucken from above. It may be the air hath some part in furthering the percussion; but the chief cause I take to be, for that the parts of the body moved have, by impulsion or by the motion of gravity continued, a compression in them as well downwards, as they have, when they are thrown or shot through the air, forwards. I conceive also that the quick loose of that motion preventeth the resistance of the body below: and priority of the force always is of great efficacy; as appeareth in infinite instances.

Experiment solitary touching titillation.

766. Tickling is most in the soles of the feet, and under the arm-holes, and on the sides. The cause is, the thinness of the

[1] Arist. Mech. Quæst. 32. [2] Id. Ib. 35.

skin in those parts, joined with the rareness of being touched there. For all tickling is a light motion of the spirits, which the thinness of the skin, and suddenness and rareness of touch, do further: for we see a feather, or a rush, drawn along the lip or cheek, doth tickle; whereas a thing more obtuse, or a touch more hard, doth not. And for suddenness, we see no man can tickle himself[1]: we see also that the palm of the hand, though it hath as thin a skin as the other parts mentioned, yet is not ticklish, because it is accustomed to be touched. Tickling also causeth laughter. The cause may be the emission of the spirits, and so of the breath, by a flight from titillation; for upon tickling we see there is ever a starting or shrinking away of the part to avoid it; and we see also, that if you tickle the nostrils with a feather, or straw, it procureth sneezing; which is a sudden emission of the spirits, that do likewise expel the moisture. And tickling is ever painful, and not well endured.

Experiment solitary touching the scarcity of rain in Egypt.[2]

767. It is strange, that the river of Nilus overflowing, as it doth, the country of Egypt, there should be nevertheless little or no rain in that country. The cause must be either in the nature of the water, or in the nature of the air, or of both. In the water, it may be ascribed either unto the long race of the water; for swift-running waters vapour not so much as standing waters; or else to the concoction of the water; for waters well concocted vapour not so much as waters raw; no more than waters upon the fire do vapour so much after some time of boiling as at the first. And it is true that the water of Nilus is sweeter than other waters in taste; and it is excellent good for the stone, and hypochondriacal melancholy; which sheweth it is lenifying; and it runneth through a country of a hot climate, and flat, without shade either of woods or hills; whereby the sun must needs have great power to concoct it. As for the air, (from whence I conceive this want of showers cometh chiefly,) the cause must be, for that the air is of itself thin and thirsty; and as soon as ever it getteth any moisture from the water, it imbibeth and dissipateth it in the whole

[1] See Arist. *Prob.* xxxv. 2. and 6.; and compare Scaliger, *Exercit. adv. Cardanum*, 317. 5.

[2] The substance of this and the next paragraph is taken from Sandys, p. 78.

body of the air; and suffereth it not to remain in vapour, whereby it might breed rain.

Experiment solitary touching clarification.

768. It hath been touched in the title of percolations (namely, such as are inwards), that the whites of eggs and milk do clarify; and it is certain that in Egypt they prepare and clarify the water of Nile, by putting it into great jars of stone, and stirring it about with a few stamped almonds; wherewith they also besmear the mouth of the vessel; and so draw it off, after it hath rested some time. It were good to try this clarifying with almonds in new beer or must, to hasten and perfect the clarifying.

Experiment solitary touching plants without leaves.

769. There be scarce to be found any vegetables that have branches and no leaves, except you allow coral for one. But there is also in the deserts of S. Macario in Egypt, a plant which is long, leafless, brown of colour, and branched like coral, save that it closeth at the top. This being set in water within house, spreadeth and displayeth strangely; and the people thereabout have a superstitious belief, that in the labour of women it helpeth to the easy deliverance.[1]

Experiment solitary touching the materials of glass.

770. The crystalline Venice glass is reported to be a mixture in equal portions of stones brought from Pavia by the river Ticinum, and the ashes of a weed, called by the Arabs *kall*, which is gathered in a desert between Alexandria and Rosetta; and is by the Egyptians used first for fuel; and then they crush the ashes into lumps like a stone, and so sell them to the Venetians for their glass-works.[2]

Experiment solitary touching prohibition of putrefaction, and the long conservation of bodies.

771. It is strange, and well to be noted, how long carcasses have continued uncorrupt, and in their former dimensions; as appeareth in the mummies of Egypt; having lasted, as is conceived, (some of them) three thousand years. It is true, they

[1] Sandys, p. 85. The word *long* is, as we see on referring to Sandys, an erratum. It ought to be *low*.
[2] Ib. p. 90.

find means to draw forth the brains, and to take forth the entrails, which are the parts aptest to corrupt. But that is nothing to the wonder: for we see what a soft and corruptible substance the flesh of all the other parts of the body is. But it should seem that, according to our observation and axiom in our hundredth experiment, putrefaction, which we conceive to be so natural a period of bodies, is but an accident; and that matter maketh not that haste to corruption that is conceived. And therefore bodies in shining amber, in quicksilver, in balms (whereof we now speak), in wax, in honey, in gums, and (it may be) in conservatories of snow, &c., are preserved very long. It need not go for repetition, if we resume again that which we said in the aforesaid experiments concerning annihilation; namely, that if you provide against three causes of putrefaction, bodies will not corrupt: the first is, that the air be excluded; for that undermineth the body, and conspireth with the spirit of the body to dissolve it. The second is, that the body adjacent and ambient be not commaterial, but merely heterogeneal towards the body that is to be preserved; for if nothing can be received by the one, nothing can issue from the other; such are quicksilver and white amber, to herbs and flies, and such bodies. The third is, that the body to be preserved be not of that gross that it may corrupt within itself, although no part of it issue into the body adjacent: and therefore it must be rather thin and small, than of bulk. There is a fourth remedy also; which is, that if the body to be preserved be of bulk, as a corpse is, then the body that incloseth it must have a virtue to draw forth and dry the moisture of the inward body; for else the putrefaction will play within, though nothing issue forth. I remember Livy doth relate, that there were found at a time two coffins of lead in a tomb; whereof the one contained the body of King Numa; it being some four hundred years after his death; and the other, his books of sacred rites and ceremonies, and the discipline of the pontiffs; and that in the coffin that had the body, there was nothing at all to be seen, but a little light cinders about the sides; but in the coffin that had the books, they were found as fresh as if they had been but newly written, being written in parchment, and covered over with watch-candles of wax three or four fold. By this it seemeth that the Romans in Numa's time were not so good embalmers as the Egyptians were; which was the

cause that the body was utterly consumed. But I find in Plutarch and others, that when Augustus Cæsar visited the sepulchre of Alexander the Great in Alexandria, he found the body to keep his dimension; but withal, that notwithstanding all the embalming, (which no doubt was of the best,) the body was so tender, as Cæsar, touching but the nose of it, defaced it.[1] Which maketh me find it very strange, that the Egyptian mummies should be reported to be as hard as stone-pitch[2]; for I find no difference but one, which indeed may be very material, namely that the ancient Egyptian mummies were shrouded in a number of folds of linen, besmeared with gums, in manner of sear-cloth; which it doth not appear was practised upon the body of Alexander.

Experiment solitary touching the abundance of nitre in certain sea-shores.

772. Near the castle of Catie, and by the wells of Assan, in the land of Idumea, a great part of the way you would think the sea were near at hand, though it be a good distance off: and it is nothing but the shining of the nitre upon the sea sands; such abundance of nitre the shores there do put forth.[3]

Experiment solitary touching bodies that are borne up by water.

773. The Dead Sea, which vomiteth up bitumen, is of that crassitude, as living bodies bound hand and foot cast into it have been borne up, and not sunk[4]; which sheweth, that all sinking into water is but an over-weight of the body put into the water in respect of the water; so that you may make water so strong and heavy, of quicksilver (perhaps) or the like, as may bear up iron; of which I see no use, but imposture. We see also that all metals except gold, for the same reason, swim upon quicksilver.

Experiment solitary touching fuel that consumeth little or nothing.

774. It is reported, that at the foot of a hill near the Mare Mortuum there is a black stone (whereof pilgrims make fires)

[1] This story is not mentioned by Plutarch, nor, so far as I am aware by any authorities except Suetonius and Dio Cassius. The latter mentions that Augustus broke off a piece of the nose. See Suet. in Aug. ii. 18., and Dio Cassius, li. § 16. The opening of Numa's coffin is described by Livy, xl. 29., who, however, does not say that any cinders were found in it.

[2] Namely, by Sandys, p. 104.

[3] Sandys, p. 109.

[4] Id. p. 110.

which burneth like a coal, and diminisheth not; but only waxeth brighter and whiter.[1] That it should do so is not strange: for we see iron red hot burneth, and consumeth not; but the strangeness is, that it should continue any time so; for iron, as soon as it is out of the fire, deadeth straightways. Certainly it were a thing of great use and profit, if you could find out fuel that would burn hot, and yet last long: neither am I altogether incredulous but there may be such candles as they say are made of salamander's wool; being a kind of mineral, which whiteneth also in the burning, and consumeth not. The question is this; flame must be made of somewhat; and commonly it is made of some tangible body which hath weight: but it is not impossible perhaps that it should be made of spirit or vapour in a body, (which spirit or vapour hath no weight,) such as is the matter of ignis fatuus. But then you will say, that that vapour also can last but a short time: to that it may be answered, that by the help of oil, and wax, and other candle-stuff, the flame may continue, and the wick not burn.

Experiment solitary œconomical touching cheap fuel.

775. Sea-coal lasts longer than charcoal; and charcoal of roots, being coaled into great pieces, lasts longer than ordinary charcoal. Turf, and peat, and cow-sheards, are cheap fuels, and last long. Small-coal, or briar-coal poured upon charcoal, make them last longer. Sedge is a cheap fuel to brew or bake with: the rather because it is good for nothing else. Trial would be made of some mixture of sea-coal with earth or chalk; for if that mixture be[2], as the sea-coal men use it, privily to make the bulk of the coal greater, it is deceit; but if it be used purposely, and be made known, it is saving.

Experiment solitary touching the gathering of wind for freshness.

776. It is at this day in use in Gaza, to couch potsheards or vessels of earth in their walls, to gather the wind from the top, and to pass it down in spouts into rooms.[3] It is a device for freshness in great heats: and it is said there are some rooms in Italy and Spain for freshness, and gathering the winds and air, in the heats of summer; but they be but pennings of the winds and enlarging them again, and making them reverberate

[1] Sandys, p. 111. But for *brighter* we ought, on the authority of the passage in Sandys, to read *lighter*.

[2] So in the original. Bacon probably wrote *be used*. — *J. S.*

[3] Sandys, p 116.

and go round in circles, rather than this device of spouts in the wall.

Experiment solitary touching the trials of airs.

777. There would be used much diligence in the choice of some bodies and places, (as it were) for the tasting of air; to discover the wholesomeness or unwholesomeness, as well of seasons, as of the seats of dwellings. It is certain that there be some houses, wherein confitures and pies will gather mould more than in others. And I am persuaded that a piece of raw flesh or fish will sooner corrupt in some airs than in others. They be noble experiments that can make this discovery; for they serve for a natural divination of seasons, better than the astronomers can by their figures: and again, they teach men where to choose their dwelling for their better health.

Experiment solitary touching increasing of milk in milch-beasts.

778. There is a kind of stone about Bethlehem, which they grind to powder and put into water whereof cattle drink; which maketh them give more milk.[1] Surely there would be some better trials made of mixtures of water in ponds for cattle, to make them more milch, or to fatten them, or to keep them from murrain. It may be chalk and nitre are of the best.

Experiment solitary touching sand of the nature of glass.

779. It is reported, that in the valley near the mountain Carmel in Judea there is a sand, which of all other hath most affinity with glass[2]; insomuch as other minerals laid in it turn to a glassy substance, without the fire; and again, glass put into it turneth into the mother-sand. The thing is very strange, if it be true: and it is likeliest to be caused by some natural furnace, or heat in the earth: and yet they do not speak of any eruption of flames. It were good to try in glass-works, whether the crude materials of glass, mingled with glass already made, and remolten, do not facilitate the making of glass with less heat.

Experiment solitary touching the growth of coral.

780. In the sea, upon the south-west of Sicily, much coral is found.[3] It is a submarine plant. It hath no leaves: it brancheth only when it is under water; it is soft, and green of

[1] Sandys, p. 142. [2] Id. p. 159. [3] Id. p. 184.

colour; but being brought into the air, it becometh hard and shining red, as we see. It is said also to have a white berry; but we find it not brought over with coral. Belike it is cast away as nothing worth: inquire better of it, for the discovery of the nature of the plant.

Experiment solitary touching the gathering of manna.

781. The manna of Calabria is the best, and in most plenty.[1] They gather it from the leaf of the mulberry-tree; but not of such mulberry-trees as grow in the valleys. And manna falleth upon the leaves by night, as other dews do. It should seem that before those dews come upon trees in the valleys, they dissipate, and cannot hold out. It should seem also, the mulberry-leaf itself hath some coagulating virtue, which inspissateth the dew; for that it is not found upon other trees: and we see by the silk-worm, which feedeth upon that leaf, what a dainty smooth juice it hath; and the leaves also (especially of the black mulberry) are somewhat bristly, which may help to preserve the dew. Certainly it were not amiss to observe a little better the dews that fall upon trees, or herbs growing on mountains; for it may be many dews fall, that spend before they come to the valleys. And I suppose that he that would gather the best May-dew for medicine, should gather it from the hills.

Experiment solitary touching the correcting of wine.

782. It is said they have a manner to prepare their Greek wines, to keep them from fuming and inebriating, by adding some sulphur or alum: whereof the one is unctuous, and the other is astringent.[2] And certain it is that those two natures do best repress fumes. This experiment would be transferred unto other wine and strong beer, by putting in some like substances while they work; which may make them both to fume less, and to inflame less.

Experiment solitary touching the materials of wild-fire.

783. It is conceived by some (not improbably) that the reason why wild-fires (whereof the principal ingredient is bitumen) do not quench with water, is, for that the first concretion of

[1] Sandys, p. 195.
[2] Id. p. 203. Sandys is speaking of the Greek wines made on the sides of Vesuvius.

bitumen is a mixture of a fiery and watery substance: so is not sulphur. This appeareth, for that in the place near Puteoli, which they call the Court of Vulcan, you shall hear under the earth a horrible thundering of fire and water conflicting together; and there break forth also spouts of boiling water.[1] Now that place yieldeth great quantities of bitumen; whereas Ætna and Vesuvius, and the like, which consist upon sulphur, shoot forth smoke, and ashes, and pumice, but no water. It is reported also, that bitumen mingled with lime, and put under water, will make as it were an artificial rock; the substance becometh so hard.

Experiment solitary touching plaster growing as hard as marble.

784. There is a cement compounded of flour, whites of eggs, and stone powdered, that becometh hard as marble: wherewith Piscina Mirabilis, near Cuma, is said to have the walls plastered.[2] And it is certain and tried, that the powder of loadstone and flint, by the addition of whites of eggs and gum-dragon, made into paste, will in a few days harden to the hardness of a stone.

Experiment solitary touching judgment of the cure in some ulcers and hurts.

785. It hath been noted by the ancients that in full or impure bodies, ulcers or hurts in the legs are hard to cure; and in the head more easy.[3] The cause is, for that ulcers or hurts in the legs require desiccation, which by the defluxion of humours to the lower parts is hindered: whereas hurts and ulcers in the head require it not; but contrariwise dryness maketh them more apt to consolidate. And in modern observation, the like difference hath been found between Frenchmen and Englishmen; whereof the one's constitution is more dry, and the other's more moist. And therefore a hurt of the head is harder to cure in a Frenchman, and of the leg in an Englishman.

Experiment solitary touching the healthfulness or unhealthfulness of the southern wind.

786. It hath been noted by the ancients that southern winds blowing much without rain, do cause a feverous disposition of the year; but with rain, not.[4] The cause is, for

[1] Sandys, p. 210. [2] Id. p. 231. [3] Arist. Prob. i. 18. [4] Id. ib. i. 23.

that southern winds do of themselves qualify the air to be apt to cause fevers; but when showers are joined, they do refrigerate in part, and check the sultry heat of the southern wind. Therefore this holdeth not in the sea coasts, because the vapour of the sea, without showers, doth refresh.

Experiment solitary touching wounds.

787. It hath been noted by the ancients, that wounds which are made with brass heal more easily than wounds made with iron.[1] The cause is, for that brass hath in itself a sanative virtue; and so in the very instant helpeth somewhat: but iron is corrosive and not sanative. And therefore it were good, that the instruments which are used by chirurgeons about wounds were rather of brass than iron.

Experiment solitary touching mortification by cold.

788. In the cold countries, when men's noses and ears are mortified and (as it were) gangrened with cold, if they come to a fire they rot off presently. The cause is, for that the few spirits that remain in those parts are suddenly drawn forth, and so putrefaction is made complete. But snow put upon them helpeth: for that it preserveth those spirits that remain, till they can revive; and besides, snow hath in it a secret warmth: as the monk proved out of the text, *qui dat nivem sicut lanam, gelu sicut cineres spargit*[2]; whereby he did infer, that snow did warm like wool, and frost did fret like ashes. Warm water also doth good; because by little and little it openeth the pores, without any sudden working upon the spirits. This experiment may be transferred unto the cure of gangrenes, either coming of themselves, or induced by too much applying of opiates; wherein you must beware of dry heat, and resort to things that are refrigerant, with an inward warmth and virtue of cherishing.

Experiment solitary touching weight.

789. Weigh iron and aqua fortis severally; then dissolve the iron in the aqua fortis, and weigh the dissolution; and you shall find it to bear as good weight as the bodies did severally; notwithstanding a good deal of waste by a thick vapour that issueth during the working; which sheweth that the opening

[1] Arist. Prob. i. 35. [2] Ps. cxlvii. 16.

of a body doth increase the weight. This was tried once or twice, but I know not whether there were any error in the trial.

Experiment solitary touching the super-natation of bodies.

790. Take of aqua fortis two ounces, of quicksilver two drachms (for that charge the aqua fortis will bear); the dissolution will not bear a flint as big as a nutmeg: yet (no doubt) the increasing of the weight of water will increase his power of bearing; as we see brine, when it is salt enough, will bear an egg. And I remember well a physician, that used to give some mineral baths for the gout, &c.; and the body, when it was put into the bath, could not get down so easily as in ordinary water. But it seemeth the weight of the quicksilver more than the weight of a stone, doth not compense the weight of a stone more than the weight of the aqua fortis.

Experiment solitary touching the flying of unequal bodies in the air.

791. Let there be a body of unequal weight (as of wood and lead, or bone and lead); if you throw it from you with the light end forward, it will turn, and the weightier end will recover to be forwards; unless the body be over-long. The cause is, for that the more dense body hath a more violent pressure of the parts from the first impulsion; which is the cause (though heretofore not found out, as hath been often said) of all violent motions; and when the hinder part moveth swifter (for that it less endureth pressure of parts) than the forward part can make way for it, it must needs be that the body turn over: for (turned) it can more easily draw forward the lighter part. Galilæus[1] noteth it well, that if an open trough, wherein water is, be driven faster than the water can follow, the water gathereth upon an heap towards the hinder end, where the motion began; which he supposeth (holding confidently the motion of the earth,) to be the cause of the ebbing and flowing of the ocean: because the earth over-runneth the water. Which theory though it be false, yet the first experiment is true. As for the inequality of the pressure of parts, it appeareth manifestly in this: that if you take a body of stone or iron, and another of wood, of the same magnitude and shape, and throw them with equal force, you cannot possibly throw the wood so far as the stone or iron.

[1] See his Dialogi del Sistemi Massimi.

Experiment solitary touching water, that it may be the medium of sounds.

792. It is certain (as it hath been formerly in part touched) that water may be the medium of sounds. If you dash a stone against a stone in the bottom of the water, it maketh a sound. So a long pole struck upon gravel in the bottom of the water maketh a sound. Nay, if you should think that the sound cometh up by the pole, and not by the water, you shall find that an anchor let down by a rope maketh a sound: and yet the rope is no solid body whereby the sound can ascend.

Experiment solitary of the flight of the spirits upon odious objects.

793. All objects of the senses which are very offensive, do cause the spirits to retire: and upon their flight the parts are (in some degree) destitute; and so there is induced in them a trepidation and horror. For sounds, we see that the grating of a saw, or any very harsh noise, will set the teeth on edge, and make all the body shiver. For tastes, we see that in the taking of a potion, or pills, the head and the neck shake. For odious smells, the like effect followeth; which is less perceived, because there is a remedy at hand by stopping of the nose; but in horses, that can use no such help, we see the smell of a carrion, especially of a dead horse, maketh them fly away, and take on almost as if they were mad. For feeling, if you come out of the sun suddenly into a shade, there followeth a chillness or shivering in all the body. And even in sight, which hath (in effect) no odious object, coming into sudden darkness induceth an offer to shiver.

Experiment solitary touching the super-reflexion of echoes.

794. There is in the city of Ticinum[1] in Italy, a church that hath windows only from above: it is in length an hundred feet, in breadth twenty feet, and in height near fifty; having a door in the midst. It reporteth the voice twelve or thirteen times, if you stand by the close end-wall over against the door. The echo fadeth, and dieth by little and little, as the echo at Pont-Charenton doth. And the voice soundeth as if it came from above the door. And if you stand at the lower

[1] That is, Pavia. For an account of the echo there, see Maiolus, *Dies Caniculares*.

end, or on either side of the door, the echo holdeth; but if you stand in the door, or in the midst just over against the door, not. Note that all echoes sound better against old walls than new; because they are more dry and hollow.

Experiment solitary touching the force of imagination imitating that of the sense.

795. Those effects which are wrought by the percussion of the sense, and by things in fact, are produced likewise in some degree by the imagination. Therefore if a man see another eat sour or acid things which set the teeth on edge, this object tainteth the imagination; so that he that seeth the thing done by another, hath his own teeth also set on edge. So if a man see another turn swiftly and long, or if he look upon wheels that turn, himself waxeth turn-sick. So if a man be upon an high place without rails or good hold, except he be used to it, he is ready to fall: for imagining a fall, it putteth his spirits into the very action of a fall. So many upon the seeing of others bleed, or strangled, or tortured, themselves are ready to faint, as if they bled, or were in strife.[1]

Experiment solitary touching preservation of bodies.

796. Take a stock-gilly-flower, and tie it gently upon a stick and put them both into a stoop-glass full of quicksilver, so that the flower be covered: then lay a little weight upon the top of the glass that may keep the stick down; and look upon them after four or five days; and you shall find the flower fresh, and the stalk harder and less flexible than it was. If you compare it with another flower gathered at the same time, it will be the more manifest. This sheweth that bodies do preserve excellently in quicksilver; and not preserve only, but by the coldness of the quicksilver indurate; for the freshness of the flower may be merely conservation; (which is the more to be observed, because the quicksilver presseth the flower;) but the stiffness of the stalk cannot be without induration, from the cold (as it seemeth) of the quicksilver.

Experiment solitary touching the growth or multiplying of metals.

797. It is reported by some of the ancients that in Cyprus there is a kind of iron, that being cut into little pieces and put

[1] Arist. Prob. vii. 7.

into the ground, if it be well watered, will increase into greater pieces.[1] This is certain, and known of old, that lead will multiply and increase; as hath been seen in old statua's of stone which have been put in cellars; the feet of them being bound with leaden bands; where (after a time) there appeared that the lead did swell; insomuch as it hanged upon the stone like warts.

Experiment solitary touching the drowning of the more base metal in the more precious.

798. I call drowning of metals, when that the baser metal is so incorporate with the more rich as it can by no means be separated again; which is a kind of version, though false: as if silver should be inseparably incorporated with gold; or copper and lead with silver. The ancient electrum had in it a fifth of silver to the gold[2]; and made a compound metal, as fit for most uses as gold, and more resplendent, and more qualified in some other properties; but then that was easily separated. This to do privily, or to make the compound pass for the rich metal simple, is an adulteration or counterfeiting: but if it be done avowedly, and without disguising, it may be a great saving of the richer metal. I remember to have heard of a man skilful in metals, that a fifteenth part of silver incorporate with gold will not be recovered by any water of separation, except you put a greater quantity of silver to draw it to the less; which (he said) is the last refuge in separations.[3] But that is a tedious way, which no man (almost) will think on. This would be better inquired: and the quantity of the fifteenth turned to a twentieth: and likewise with some little additional, that may further the intrinsic incorporation. Note that silver in gold will be detected, by weight compared with the dimension; but lead in silver (lead being the weightier metal) will not be detected, if you take so much the more silver as will countervail the over-weight of the lead.[4]

[1] Arist. Mirab. 43. But it is doubtful whether the pseudo-Aristotle is speaking of iron or of brass. The best editions are in favour of the latter.

[2] Pliny, xxxiii. 23.; but compare Hardouin's note. On the subject of Electrum, see an essay in Buttmann's *Mythologus*.

[3] This is called quartation.

[4] It is strange that Bacon should not have seen that by taking away more silver you diminish the dimension. The only way in which an alloy of lead and silver could escape detection by the test used by Archimedes, or at least by more exact methods of the same kind, would be to make some part of the work hollow. But if this was Bacon's meaning, he has not expressed it. It is yet more strange, the intention of the experiment being to effect a saving of the precious metal, that he should

Experiment solitary touching fixation of bodies.

799. Gold is the only substance which hath nothing in it volatile, and yet melteth without much difficulty. The melting sheweth that it is not jejune, or scarce in spirit. So that the fixing of it is not want of spirit to fly out, but the equal spreading of the tangible parts, and the close coacervation of them: whereby they have the less appetite, and no means at all to issue forth. It were good therefore to try, whether glass remolten do leese any weight? for the parts in glass are evenly spread; but they are not so close as in gold; as we see by the easy admission of light, heat, and cold; and by the smallness of the weight. There be other bodies fixed, which have little or no spirit; so as there is nothing to fly out; as we see in the stuff whereof copples are made, which they put into furnaces; upon which fire worketh not. So that there are three causes of fixation; the even spreading both of the spirits and tangible parts; the closeness of the tangible parts; and the jejuneness or extreme comminution of spirits: of which three, the two first may be joined with a nature liquefiable, the last not.

Experiment solitary touching the restless nature of things in themselves, and their desire to change.

800. It is a profound contemplation in nature, to consider of the emptiness (as we may call it) or insatisfaction of several bodies; and of their appetite to take in others. Air taketh in lights, and sounds, and smells, and vapours; and it is most manifest that it doth it with a kind of thirst, as not satisfied with his own former consistence; for else it would never receive them in so suddenly and easily. Water and all liquors do hastily receive dry and more terrestrial bodies, proportionable: and dry bodies, on the other side, drink in waters and liquors: so that (as it was well said by one of the ancients, of earthy and watery substances) one is a glue to another. Parchment, skins, cloth, &c., drink in liquors, though themselves be entire bodies, and not comminuted, as sand and ashes, nor apparently porous: metals themselves do receive in readily

have spoken as if turning a fifteenth into a twentieth were an improvement. But perhaps he meant to make detection yet more difficult. We may remark farther, that all gold in common use contains more than a fifteenth of alloy. The money standard of England, which is above the average of continental coinages, contains one part of alloy to eleven of fine gold.

strong-waters; and strong-waters likewise do readily pierce into metals and stones: and that strong-water will touch upon gold, that will not touch upon silver; and *è converso*. And gold, which seemeth by the weight to be the closest and most solid body, doth greedily drink in quicksilver. And it seemeth that this reception of other bodies is not violent: for it is many times reciprocal, and as it were with consent. Of the cause of this, and to what axiom it may be referred, consider attentively: for as for the pretty assertion, that matter is like a common strumpet that desireth all forms, it is but a wandering notion. Only flame doth not content itself to take in any other body; but either to overcome and turn another body into itself, as by victory; or itself to die, and go out.

NATURAL HISTORY.

CENTURY IX.

Experiments in consort touching perception in bodies insensible, tending to natural divination or subtile trials.

It is certain that all bodies whatsoever, though they have no sense, yet they have perception: for when one body is applied to another, there is a kind of election to embrace that which is agreeable, and to exclude or expel that which is ingrate: and whether the body be alterant or altered, evermore a perception precedeth operation; for else all bodies would be alike one to another. And sometimes this perception, in some kind of bodies, is far more subtile than the sense; so that the sense is but a dull thing in comparison of it: we see a weather-glass will find the least difference of the weather in heat or cold, when men find it not. And this perception also is sometimes at distance, as well as upon the touch; as when the loadstone draweth iron; or flame fireth naphtha of Babylon, a great distance off.[1] It is therefore a subject of a very noble inquiry, to inquire of the more subtile perceptions; for it is another key to open nature, as well as the sense; and sometimes better. And besides, it is a principal means of natural divination; for that which in these perceptions appeareth early, in the great effects cometh long after. It is true also that it serveth to discover that which is hid, as well as to foretell that which is to come; as it is in many subtile trials; as to try whether seeds be old or new,

[1] Pliny, ii. 109.

the sense cannot inform; but if you boil them in water, the new seeds will sprout sooner: and so of water, the taste will not discover the best water; but the speedy consuming of it, and many other means which we have heretofore set down, will discover it. So in all physiognomy, the lineaments of the body will discover those natural inclinations of the mind, which dissimulation will conceal, or discipline will suppress. We shall therefore now handle only those two perceptions, which pertain to natural divination and discovery; leaving the handling of perception in other things to be disposed elsewhere. Now it is true that divination is attained by other means; as if you know the causes, if you know the concomitants, you may judge of the effect to follow: and the like may be said of discovery; but we tie ourselves here to that divination and discovery chiefly, which is caused by an early or subtile perception.

The aptness or propension of air or water to corrupt or putrefy, (no doubt) is to be found before it break forth into manifest effects of diseases, blastings, or the like. We will therefore set down some prognostics of pestilential and unwholesome years.

801. The wind blowing much from the south without rain, and worms in the oak-apple, have been spoken of before. Also the plenty of frogs, grasshoppers, flies, and the like creatures bred of putrefaction, doth portend pestilential years.

802. Great and early heats in the spring (and namely in May) without winds, portend the same; and generally so do years with little wind or thunder.

803. Great droughts in summer lasting till towards the end of August, and some gentle showers upon them, and then some dry weather again, do portend a pestilent summer the year following: for about the end of August all the sweetness of the earth, which goeth into plants or trees, is exhaled (and much more if the August be dry); so that nothing then can breathe forth of the earth but a gross vapour, which is apt to corrupt the air: and that vapour, by the first showers, if they be gentle, is released, and cometh forth abundantly. Therefore they that come abroad soon after those showers, are commonly taken with sickness: and in Africk, nobody will stir out of

doors after the first showers. But if the showers come vehemently, then they rather wash and fill the earth, than give it leave to breathe forth presently. But if dry weather come again, then it fixeth and continueth the corruption of the air, upon the first showers begun; and maketh it of ill influence, even to the next summer; except a very frosty winter discharge it; which seldom succeedeth such droughts.

804. The lesser infections, of the small-pox, purple fevers, agues, in the summer precedent, and hovering all winter, do portend a great pestilence in the summer following; for putrefaction doth not rise to his height at once.

805. It were good to lay a piece of raw flesh or fish in the open air; and if it putrefy quickly, it is a sign of a disposition in the air to putrefaction. And because you cannot be informed whether the putrefaction be quick or late, except you compare this experiment with the like experiment in another year, it were not amiss in the same year, and at the same time, to lay one piece of flesh or fish in the open air, and another of the same kind and bigness within doors: for I judge, that if a general disposition be in the air to putrefy, the flesh or fish will sooner putrefy abroad, where the air hath more power, than in the house, where it hath less, being many ways corrected. And this experiment would be made about the end of March: for that season is likest to discover what the winter hath done, and what the summer following will do, upon the air. And because the air (no doubt) receiveth great tincture and infusion from the earth; it were good to try that exposing of flesh or fish, both upon a stake of wood some height above the earth, and upon the flat of the earth.

806. Take May-dew, and see whether it putrefy quickly or no; for that likewise may disclose the quality of the air, and vapour of the earth, more or less corrupted.

807. A dry March, and a dry May, portend a wholesome summer, if there be a showering April between: but otherwise it is a sign of a pestilential year.

808. As the discovery of the disposition of the air is good for the prognostics of wholesome and unwholesome years; so it is of much more use for the choice of places to dwell in: at the least, for lodges and retiring places for health (for mansion-houses respect provisions as well as health); wherein the experiments above-mentioned may serve.

809. But for the choice of places or seats, it is good to make trial not only of aptness of air to corrupt, but also of the moisture and dryness of the air, and the temper of it in heat or cold; for that may concern health diversly. We see that there be some houses wherein sweet-meats will relent, and baked meats will mould, more than in others; and wainscots will also sweat more; so that they will almost run with water: all which (no doubt) are caused chiefly by the moistness of the air in those seats. But because it is better to know it before a man buildeth his house, than to find it after, take the experiments following.

810. Lay wool, or a spunge, or bread, in the place you would try, comparing it with some other places; and see whether it doth not moisten, and make the wool, or spunge, &c., more ponderous than the other: and if it do, you may judge of that place as situate in a gross and moist air.

811. Because it is certain that in some places, either by the nature of the earth, or by the situation of woods and hills, the air is more unequal than in others; and inequality of air is ever an enemy to health; it were good to take two weather-glasses, matches in all things, and to set them, for the same hours of one day, in several places, where no shade is, nor inclosures; and to mark when you set them, how far the water cometh; and to compare them, when you come again, how the water standeth then; and if you find them unequal, you may be sure that the place where the water is lowest is in the warmer air, and the other in the colder. And the greater the inequality be of the ascent or descent of the water, the greater is the inequality of the temper of the air.

812. The predictions likewise of cold and long winters, and hot and dry summers, are good to be known; as well for the discovery of the causes, as for divers provisions. That of plenty of haws, and heps, and briar-berries, hath been spoken of before. If wainscot, or stone, that have used to sweat, be more dry in the beginning of winter; or the drops of the eaves of houses come more slowly down than they use; it portendeth a hard and frosty winter. The cause is, for that it sheweth an inclination of the air to dry weather; which in winter is ever joined with frost.

813. Generally a moist and a cool summer portendeth a hard winter. The cause is, for that the vapours of the earth are not

dissipated in the summer by the sun; and so they rebound upon the winter.

814. A hot and dry summer and autumn, and especially if the heat and drought extend far into September, portendeth an open beginning of winter; and colds to succeed, toward the latter part of the winter and the beginning of the spring: for till then the former heat and drought bear the sway, and the vapours are not sufficiently multiplied.

815. An open and warm winter portendeth a hot and dry summer; for the vapours disperse into the winter showers; whereas cold and frost keepeth them in, and transporteth them into the late spring and summer following.

816. Birds that use to change countries at certain seasons, if they come earlier, do shew the temperature of weather, according to that country whence they came: as the winter-birds, (namely, woodcocks, feldfares, &c.) if they come earlier, and out of the northern countries, with us shew cold winters. And if it be in the same country, then they shew a temperature of season like unto that season in which they come: as swallows, bats, cuckoos, &c., that come towards summer, if they come early, shew a hot summer to follow.

817. The prognostics, more immediate, of weather to follow soon after, are more certain than those of seasons. The resounding of the sea upon the shore; and the murmur of winds in the woods, without apparent wind; shew wind to follow: for such winds breathing chiefly out of the earth, are not at the first perceived, except they be pent by water or wood. And therefore a murmur out of caves likewise portendeth as much.[1]

818. The upper regions of the air perceive the collection of the matter of tempests and winds, before the air here below: and therefore the obscuring of the smaller stars is a sign of tempests following. And of this kind you shall find a number of instances in our inquisition *De Ventis*.

819. Great mountains have a perception of the disposition of the air to tempests, sooner than the valleys or plains below: and therefore they say in Wales, when certain hills have their night-caps on, they mean mischief. The cause is, for that tempests, which are for the most part bred above in the middle region (as they call it), are soonest perceived to collect in the places next it.

[1] Most of these prognostics are mentioned by Pliny.

820. The air, and fire, have subtile perceptions of wind rising, before men find it. We see the trembling of a candle will discover a wind that otherwise we do not feel; and the flexuous burning of flames doth shew the air beginneth to be unquiet; and so do coals of fire by casting off the ashes more than they use. The cause is, for that no wind at the first, till it hath struck and driven the air, is apparent to the sense; but flame is easier to move than air: and for the ashes, it is no marvel, though wind unperceived shake them off; for we usually try which way the wind bloweth, by casting up grass, or chaff, or such light things into the air.

821. When wind expireth from under the sea, as it causeth some resounding of the water (whereof we spake before), so it causeth some light motions of bubbles, and white circles of froth. The cause is, for that the wind cannot be perceived by the sense, until there be an eruption of a great quantity from under the water; and so it getteth into a body: whereas in the first putting up it cometh in little portions.

822. We spake of the ashes that coals cast off; and of grass and chaff carried by the wind: so any light thing that moveth when we find no wind, sheweth a wind at hand; as when feathers, or down of thistles, fly to and fro in the air.

For prognostics of weather from living creatures, it is to be noted that creatures that live in the open air (*sub dio*) must needs have a quicker impression from the air, than men that live most within doors; and especially birds who live in the air freest and clearest; and are aptest by their voice to tell tales what they find, and likewise by the motion of their flight to express the same.

823. Water-fowls, (as sea-gulls, moor-hens, &c.) when they flock and fly together from the sea towards the shores; and contrariwise, land-birds, (as crows, swallows, &c.) when they fly from the land to the waters, and beat the waters with their wings; do foreshew rain and wind. The cause is, pleasure that both kinds take in the moistness and density of the air; and so desire to be in motion and upon the wing, whithersoever they would otherwise go; for it is no marvel, that water-fowl do joy most in that air which is likest water; and land-birds also, many of them, delight in bathing, and moist air. For the

same reason also, many birds do prune[1] their feathers; and geese do gaggle; and crows seem to call upon rain: all which is but the comfort they seem to receive in the relenting of the air.

824. The heron, when she soareth high, (so as sometimes she is seen to pass over a cloud,) sheweth winds: but kites flying aloft shew fair and dry weather. The cause may be, for that they both mount most into the air of that temper wherein they delight: and the heron, being a water-fowl, taketh pleasure in the air that is condensed; and besides, being but heavy of wing, needeth the help of the grosser air. But the kite affecteth not so much the grossness of the air, as the cold and freshness thereof: for being a bird of prey, and therefore hot, she delighteth in the fresh air; and (many times) flieth against the wind, as trouts and salmons swim against the stream. And yet it is true also, that all birds find an ease in the depth of the air, as swimmers do in a deep water. And therefore when they are aloft, they can uphold themselves with their wings spread, scarce moving them.

825. Fishes, when they play towards the top of the water, do commonly foretell rain. The cause is, for that a fish, hating the dry, will not approach the air till it groweth moist; and when it is dry, will fly it, and swim lower.

826. Beasts do take comfort (generally) in a moist air; and it maketh them eat their meat better; and therefore sheep will get up betimes in the morning to feed, against rain: and cattle, and deer, and coneys, will feed hard before rain; and a heifer will put up his nose and snuff in the air, against rain.

827. The trefoil, against rain, swelleth in the stalk; and so standeth more upright: for by wet, stalks do erect, and leaves bow down. There is a small red flower in the stubble-fields, which country people call the wincopipe; which if it open in the morning, you may be sure of a fair day to follow.

828. Even in men, aches and hurts and corns do engrieve, either towards rain or towards frost: for the one maketh the humours more to abound; and the other maketh them sharper. So we see both extremes bring the gout.

829. Worms, vermin, &c., do foreshew likewise rain: for earthworms will come forth, and moles will cast up more, and fleas bite more, against rain.

830. Solid bodies likewise foreshew rain. As stones and

[1] *Proine* in the original.—*J. S.*

wainscot, when they sweat: and boxes and pegs of wood, when they draw and wind hard; though the former be but from an outward cause; for that the stone or wainscot turneth and beateth back the air against itself; but the latter is an inward swelling of the body of the wood itself.

Experiment solitary touching the nature of appetite in the stomach.

831. Appetite is moved chiefly by things that are cold and dry: the cause is, for that cold is a kind of indigence of nature, and calleth upon supply; and so is dryness: and therefore all sour things (as vinegar, juice of lemons, oil of vitriol, &c.) provoke appetite. And the disease which they call *appetitus caninus*, consisteth in the matter of an acid and glassy phlegm in the mouth of the stomach. Appetite is also moved by sour things; for that sour things induce a contraction in the nerves placed in the mouth of the stomach; which is a great cause of appetite. As for the cause why onions, and salt, and pepper, in baked meats, move appetite, it is by vellication of those nerves; for motion whetteth. As for wormwood, olives, capers, and others of that kind, which participate of bitterness, they move appetite by abstersion. So as there be four principal causes of appetite; the refrigeration of the stomach, joined with some dryness; contraction; vellication; and abstersion; besides hunger, which is an emptiness: and yet over-fasting doth (many times) cause the appetite to cease; for that want of meat maketh the stomach draw humours, and such humours as are light and choleric, which quench appetite most.

Experiment solitary touching sweetness of odour from the rainbow.

832. It hath been observed by the ancients, that where a rainbow seemeth to hang over or to touch, there breatheth forth a sweet smell.[1] The cause is, for that this happeneth but in certain matters which have in themselves some sweetness; which the gentle dew of the rainbow doth draw forth: and the like do soft showers; for they also make the grounds sweet: but none are so delicate as the dew of the rainbow where it falleth. It may be also that the water itself hath some sweetness; for the rainbow consisteth of a glomeration of small

[1] Arist. Prob. xii. 2.

drops, which cannot possibly fall but from the air that is very low; and therefore may hold the very sweetness of the herbs and flowers, as a distilled water; for rain, and other dew, that fall from high, cannot preserve the smell, being dissipated in the drawing up: neither do we know whether some water itself may not have some degree of sweetness. It is true that we find it sensibly in no pool, river, nor fountain; but good earth, newly turned up, hath a freshness and good scent; which water, if it be not too equal, (for equal objects never move the sense,) may also have. Certain it is, that bay-salt, which is but a kind of water congealed, will sometimes smell like violets.

Experiment solitary touching sweet smells.

833. To sweet smells heat is requisite, to concoct the matter; and some moisture, to spread the breath of them. For heat, we see that woods and spices are more odorate in the hot countries than in the cold: for moisture, we see that things too much dried lose their sweetness: and flowers growing, smell better in a morning or evening than at noon. Some sweet smells are destroyed by approach to the fire; as violets, wall-flowers, gilly-flowers, pinks; and generally all flowers that have cool and delicate spirits. Some continue both on the fire, and from the fire; as rose-water, &c. Some do scarce come forth, or at least not so pleasantly, as by means of the fire; as juniper, sweet gums, &c., and all smells that are enclosed in a fast body: but (generally) those smells are the most grateful, where the degree of heat is small; or where the strength of the smell is allayed; for these things do rather woo the sense, than satiate it. And therefore the smell of violets and roses exceedeth in sweetness that of spices and gums; and the strongest sort of smells are best in a weft afar off.

Experiment solitary touching the corporeal substance of smells.

834. It is certain that no smell issueth but with emission of some corporeal substance; not as it is in light and colours, and in sounds. For we see plainly that smell doth spread nothing that distance that the other do. It is true that some woods of oranges, and heaths of rosemary, will smell a great way into the sea, perhaps twenty miles; but what is that, since a peal of ordnance will do as much, which moveth in a small

compass? whereas those woods and heaths are of vast spaces; besides, we see that smells do adhere to hard bodies; as in perfuming of gloves, &c.; which showeth them corporeal; and do last a great while, which sounds and light do not.

Experiment solitary touching fetid and fragrant odours.

835. The excrements of most creatures smell ill; chiefly to the same creature that voideth them: for we see, besides that of man, that pigeons and horses thrive best, if their houses and stables be kept sweet: and so of cage birds: and the cat burieth that which she voideth: and it holdeth chiefly in those beasts which feed upon flesh. Dogs (almost) only of beasts delight in fetid odours; which showeth there is somewhat in their sense of smell differing from the smells of other beasts. But the cause why excrements smell ill, is manifest; for that the body itself rejecteth them; much more the spirits: and we see that those excrements that are of the first digestion, smell the worst; as the excrements from the belly; those that are from the second digestion less ill; as urine: and those that are from the third, yet less; for sweat is not so bad as the other two; especially of some persons, that are full of heat. Likewise most putrefactions are of an odious smell: for they smell either fetid or mouldy. The cause may be, for that putrefaction doth bring forth such a consistence, as is most contrary to the consistence of the body whilst it is sound: for it is a mere dissolution of that form. Besides, there is another reason, which is profound: and it is, that the objects that please any of the senses have all some equality, and (as it were) order, in their composition; but where those are wanting, the object is ever ingrate. So mixture of many disagreeing colours is ever unpleasant to the eye: mixture of discordant sounds is unpleasant to the ear: mixture or hotch-potch of many tastes is unpleasant to the taste: harshness and ruggedness of bodies is unpleasant to the touch: now it is certain that all putrefaction, being a dissolution of the first form, is a mere confusion and unformed mixture of the part. Nevertheless it is strange, and seemeth to cross the former observation, that some putrefactions and excrements do yield excellent odours; as civet and musk; and, as some think, ambergrise: for divers take it, though unprobably, to come from the sperm of fish: and the moss we spake of from apple trees is little better than an

excretion. The reason may be, for that there passeth in the excrements, and remaineth in the putrefactions, some good spirits; especially where they proceed from creatures that are very hot. But it may be also joined with a further cause, which is more subtile; and it is, that the senses love not to be over-pleased, but to have a commixture of somewhat that is in itself ingrate. Certainly we see how discords in music, falling upon concords, make the sweetest strains: and we see again what strange tastes delight the taste; as red herrings, caviary, parmesan, &c. And it may be the same holdeth in smells: for those kind of smells that we have mentioned are all strong, and do pull and vellicate the sense. And we find also, that places where men urine, commonly have some smell of violets: and urine, if one hath eaten nutmeg, hath so too.

The slothful, general, and indefinite contemplations and notions of the elements and their conjugations; of the influences of heaven; of heat, cold, moisture, drought; qualities active, passive; and the like; have swallowed up the true passages, and processes, and affects, and consistencies of matter and natural bodies. Therefore they are to be set aside, being but notional and ill limited; and definite axioms are to be drawn out of measured instances: and so ascent[1] to be made to the more general axioms, by scale. And of these kinds of processes of natures and characters of matter, we will now set down some instances.

Experiment solitary touching the causes of putrefaction.

836. All putrefactions come chiefly from the inward spirits of the body; and partly also from the ambient body, be it air, liquor, or whatsoever else. And this last by two means: either by ingress of the substance of the ambient body into the body putrefied; or by excitation and solicitation of the body putrefied, and the parts thereof, by the body ambient. As for the received opinion, that putrefaction is caused either by cold or peregrine and preternatural heat, it is but nugation: for cold, in things inanimate, is the greatest enemy that is to putrefaction; though it extinguisheth vivification, which ever consisteth in spirits attenuate, which the cold doth congeal and

[1] *Assent* in the original; a misprint, no doubt; or the mistake of an amanuensis writing from dictation. — *J. S.*

coagulate. And as for the peregrine heat, it is thus far true; that if the proportion of the adventive heat be greatly predominant to the natural heat and spirits of the body, it tendeth to dissolution, or notable alteration. But this is wrought by emission, or suppression, or suffocation, of the native spirits; and also by the disordination and discomposture of the tangible parts; and other passages of nature; and not by a conflict of heats.

Experiment solitary touching bodies unperfectly mixed.

837. In versions, or main alterations of bodies, there is a medium between the body as it is at first, and the body resulting; which medium is *corpus imperfecte mistum*, and is transitory, and not durable; as mists, smokes, vapours, chylus in the stomach, living creatures in the first vivification: and the middle action, which produceth such imperfect bodies, is fitly called (by some of the ancients) inquination[1], or inconcoction, which is a kind of putrefaction; for the parts are in confusion, till they settle one way or other.

Experiment solitary touching concoction and crudity.

838. The word concoction, or digestion, is chiefly taken into use from living creatures and their organs; and from thence extended to liquors and fruits, &c. Therefore they speak of meat concocted; urine and excrements concocted; and the four digestions, (in the stomach, in the liver, in the arteries and nerves, and in the several parts of the body,) are likewise called concoctions; and they are all made to be the works of heat: all which notions are but ignorant catches of a few things which are most obvious to men's observations. The constantest notion of concoction is, that it should signify the degrees of alteration of one body into another, from crudity to perfect concoction; which is the ultimity of that action or process; and while the body to be converted and altered is too strong for the efficient that should convert or alter it, (whereby it resisteth and holdeth fast in some degree the first form or consistence,) it is (all that while) crude and inconcoct; and the process is to be called crudity and inconcoction. It is true that concoction is in great part the work of heat; but not

[1] μόλυνσις, Arist. Meteor. iv. 3. But μόλυνσις is only one kind of inconcoction, namely that which is opposed to ἕψησις or elixation. The whole train of thought, from 836. to 846. inclusive, shows that these paragraphs were suggested by the fourth book of the *Meteorologics*.

the work of heat alone: for all things that further the conversion or alteration (as rest, mixture of a body already concocted, &c.) are also means to concoction. And there are of concoction two periods; the one assimilation, or absolute conversion and subaction; the other maturation: whereof the former is most conspicuous in the bodies of living creatures; in which there is an absolute conversion and assimilation of the nourishment into the body; and likewise in the bodies of plants; and again in metals, where there is a full transmutation. The other (which is maturation) is seen in liquors and fruits; wherein there is not desired, nor pretended, an utter conversion, but only an alteration to that form which is most sought for man's use; as in clarifying of drinks, ripening of fruits, &c. But note that there be two kinds of absolute conversions; the one is, when a body is converted into another body, which was before; as when nourishment is turned into flesh: that is it which we call assimilation. The other is, when the conversion is into a body merely new, and which was not before; as if silver should be turned to gold, or iron to copper: and this conversion is better called, for distinction's sake, transmutation.

Experiment solitary touching alterations which may be called majors.

839. There are also divers other great alterations of matter and bodies, besides those that tend to concoction and maturation; for whatsoever doth so alter a body, as it returneth not again to that it was, may be called *alteratio major;* as when meat is boiled, or roasted, or fried, &c.; or when bread and meat are baked; or when cheese is made of curds, or butter of cream, or coals of wood, or bricks of earth; and a number of others. But to apply notions philosophical to plebeian terms; or to say, where the notions cannot fitly be reconciled, that there wanteth a term or nomenclature for it (as the ancients used); they be but shifts of ignorance; for knowledge will be ever a wandering and indigested thing, if it be but a commixture of a few notions that are at hand and occur, and not excited from sufficient number of instances, and those well collated.

The consistencies of bodies are very divers[1]: dense, rare; tangible, pneumatical; volatile, fixed; determinate, not

[1] Compare the list in the *De Augmentis* [Vol. I. p. 560.].

determinate; hard, soft; cleaving, not cleaving; congealable, not congealable; liquefiable, not liquefiable; fragile, tough; flexible, inflexible; tractile, or to be drawn forth in length, intractile; porous, solid; equal and smooth, unequal; venous and fibrous and with grains, entire; and divers others; all which to refer to heat, and cold, and moisture, and drought, is a compendious and inutile speculation. But of these see principally our *Abecedarium Naturæ;* and otherwise *sparsim* in this our *Sylva Sylvarum:* nevertheless, in some good part, we shall handle divers of them now presently.

Experiment solitary touching bodies liquefiable, and not liquefiable.

840. Liquefiable, and not liquefiable, proceed from these causes: liquefaction is ever caused by the detention of the spirits, which play within the body and open it. Therefore such bodies as are more turgid of spirit, or that have their spirits more straitly imprisoned, or again that hold them better pleased and content, are liquefiable: for these three dispositions of bodies do arrest the emission of the spirits. An example of the first two properties is in metals; and of the last in grease, pitch, sulphur, butter, wax, &c. The disposition not to liquefy proceedeth from the easy emission of the spirits, whereby the grosser parts contract; and therefore bodies jejune of spirits, or which part with their spirits more willingly, are not liquefiable; as wood, clay, free-stone, &c. But yet even many of those bodies that will not melt, or will hardly melt, will notwithstanding soften: as iron in the forge; and a stick bathed in hot ashes, which thereby becometh more flexible. Moreover there are some bodies which do liquefy or dissolve by fire; as metals, wax, &c.; and other bodies which dissolve in water; as salt, sugar, &c. The cause of the former proceedeth from the dilatation of the spirits by heat: the cause of the latter proceedeth from the opening of the tangible parts, which desire to receive the liquor. Again, there are some bodies that dissolve with both; as gum, &c. And those be such bodies, as on the one side have good store of spirit; and on the other side, have the tangible parts indigent of moisture; for the former helpeth to the dilating of the spirits by the fire; and the latter stimulateth the parts to receive the liquor.

Experiment solitary touching bodies fragile and tough.

841. Of bodies, some are fragile; and some are tough, and not fragile: and in the breaking, some fragile bodies break but where the force is; some shatter and fly in many pieces. Of fragility, the cause is an impotency to be extended; and therefore stone is more fragile than metal; and so fictile earth is more fragile than crude earth; and dry wood than green. And the cause of this unaptness to extension is the small quantity of spirits, (for it is the spirit that furthereth the extension or dilatation of bodies,) and it is ever concomitant with porosity, and with dryness in the tangible parts: contrariwise, tough bodies have more spirit, and fewer pores, and moister tangible parts: therefore we see that parchment or leather will stretch, paper will not; woollen cloth will tenter, linen scarcely.

Experiment solitary touching the two kinds of pneumaticals in bodies.

842. All solid bodies consist of parts of two several natures; pneumatical and tangible; and it is well to be noted, that the pneumatical substance is in some bodies the native spirit of the body; and in some other, plain air that is gotten in; as in bodies desiccate by heat or age: for in them, when the native spirit goeth forth, and the moisture with it, the air with time getteth into the pores. And those bodies are ever the more fragile; for the native spirit is more yielding and extensive (especially to follow the parts) than air. The native spirits also admit great diversity; as hot, cold, active, dull, &c., whence proceed most of the virtues and qualities (as we call them) of bodies: but the air intermixed is without virtues, and maketh things insipid, and without any extimulation.

Experiment solitary touching concretion and dissolution of bodies.

843. The concretion of bodies is (commonly) solved by the contrary; as ice, which is congealed by cold, is dissolved by heat; salt and sugar, which are excocted by heat, are dissolved by cold and moisture.[1] The cause is, for that these operations are rather returns to their former nature, than alterations; so that the contrary cureth. As for oil, it doth

[1] Arist. Meteor. iv. 5.

neither easily congeal with cold, nor thicken with heat. The cause of both effects, though they be produced by contrary efficients, seemeth to be the same; and that is, because the spirit of the oil by either means exhaleth little; for the cold keepeth it in; and the heat (except it be vehement) doth not call it forth. As for cold, though it take hold of the tangible parts, yet as to the spirits, it doth rather make them swell than congeal them: as when ice is congealed in a cup, the ice will swell instead of contracting, and sometimes rift.

Experiment solitary touching hard and soft bodies.

844. Of bodies, some (we see) are hard, and some soft: the hardness is caused (chiefly) by the jejuneness of the spirits, and their imparity with the tangible parts: both which, if they be in a greater degree, maketh them not only hard, but fragile, and less enduring of pressure; as steel, stone, glass, dry wood, &c. Softness cometh (contrariwise) by the greater quantity of spirits, (which ever helpeth to induce yielding and cession,) and by the more equal spreading of the tangible parts, which thereby are more sliding and following: as in gold, lead, wax, &c. But note that soft bodies (as we use the word) are of two kinds; the one, that easily giveth place to another body, but altereth not bulk, by rising in other places: and therefore we see that wax, if you put any thing into it, doth not rise in bulk, but only giveth place; for you may not think, that in printing of wax, the wax riseth up at all; but only the depressed part giveth place, and the other remaineth as it was. The other, that altereth bulk in the cession; as water, or other liquors, if you put a stone or any thing into them, they give place indeed easily, but then they rise all over; which is a false cession; for it is in place, and not in body.

Experiment solitary touching bodies ductile and tensile.

845. All bodies ductile and tensile (as metals, that will be drawn into wires; wool and tow, that will be drawn into yarn or thread,) have in them the appetite of not discontinuing, strong; which maketh them follow the force that pulleth them out; and yet so as not to discontinue or forsake their own body. Viscous bodies likewise, as pitch, wax, bird-lime, cheese toasted, will draw forth and rope. But the difference between bodies fibrous and bodies viscous is plain: for all

wool, and tow, and cotton, and silk (especially raw silk) have, besides their desire of continuance, in regard of the tenuity of their thread, a greediness of moisture; and by moisture to join and incorporate with other thread; especially if there be a little wreathing; as appeareth by the twisting of thread, and the practice of twirling about of spindles. And we see also that gold and silver thread cannot be made without twisting.

Experiment solitary touching other passions of matter, and characters of bodies.

846. The differences of impressible and not impressible; figurable and not figurable; mouldable and not mouldable; scissile and not scissile; and many other passions of matter[1], are plebeian notions, applied unto the instruments and uses which men ordinarily practise; but they are all but the effects of some of these causes following, which we will enumerate without applying them, because that would be too long. The first is the cession or not cession of bodies into a smaller space or room, keeping the outward bulk, and not flying up. The second is the stronger or weaker appetite in bodies to continuity, and to fly discontinuity. The third is the disposition of bodies to contract, or not contract: and again, to extend, or not extend. The fourth is the small quantity or great quantity of the pneumatical in bodies. The fifth is the nature of the pneumatical, whether it be native spirit of the body, or common air. The sixth is the nature of the native spirits in the body, whether they be active and eager, or dull and gentle. The seventh is the emission or detention of the spirits in bodies. The eighth is the dilatation or contraction of the spirits in bodies, while they are detained. The ninth is the collocation of the spirits in bodies; whether the collocation be equal or unequal; and again, whether the spirits be coacervate or diffused. The tenth is the density or rarity of the tangible parts. The eleventh is the equality or inequality of the tangible parts. The twelfth is the digestion or crudity of the tangible parts. The thirteenth is the nature of the matter, whether sulphureous or mercurial, watery or oily, dry and terrestrial, or moist and liquid; which natures of sulphureous and mercurial, seem to be natures radical and principal. The fourteenth is the placing of the tangible parts in length, or

[1] See Aristotle's list, *Meteor.* iv. 8.

transverse (as it is in the warp and the woof of textiles); more inward or more outward, &c. The fifteenth is the porosity or imporosity betwixt the tangible parts, and the greatness or smallness of the pores. The sixteenth is the collocation and posture of the pores. There may be more causes; but these do occur for the present.

Experiment solitary touching induration by sympathy.

847. Take lead and melt it, and in the midst of it, when it beginneth to congeal, make a little dint or hole, and put quicksilver wrapped in a piece of linen into that hole, and the quicksilver will fix, and run no more, and endure the hammer. This is a noble instance of induration, by consent of one body with another, and motion of excitation to imitate; for to ascribe it only to the vapour of lead, is less probable. *Quære* whether the fixing may be in such a degree, as it will be figured like other metals? For if so, you may make works of it for some purposes, so they come not near the fire.

Experiment solitary touching honey and sugar.

848. Sugar hath put down the use of honey; insomuch as we have lost those observations and preparations of honey which the ancients had, when it was more in price. First, it seemeth that there was in old time tree-honey, as well as bee-honey; which was the tear or blood issuing from the tree: insomuch as one of the ancients relateth, that in Trebisond there was honey issuing from the box-trees which made men mad.[1] Again, in ancient time there was a kind of honey which, either of the own nature or by art, would grow as hard as sugar, and was not so luscious as ours. They had also a wine of honey, which they made thus. They crushed the honey into a great quantity of water, and then strained the liquor; after, they boiled it in a copper to the half; then they poured it into earthen vessels for a small time; and after tunned it into vessels of wood, and kept it for many years. They have also at this day, in Russia and those northern countries, mead simple, which (well made and seasoned) is a good wholesome drink, and very clear. They use also in Wales a compound drink of mead, with herbs and spices. But meanwhile it were good, in recompence of

[1] Arist. Mirab. 17. The honey was made from box; that is, apparently, by bees which fed on the box flower. There is no authority for saying that it issued from the box tree.

that we have lost in honey, there were brought in use a *sugar-mead,* (for so we may call it) though without any mixture at all of honey; and to brew it, and keep it stale, as they use mead: for certainly, though it would not be so abstersive, and opening, and solutive a drink as mead: yet it will be more grateful to the stomach, and more lenitive, and fit to be used in sharp diseases: for we see that the use of sugar in beer and ale hath good effects in such cases.[1]

Experiment solitary touching the finer sort of base metals.

849. It is reported by the ancients, that there was a kind of steel in some places, which would polish almost as white and bright as silver.[2] And that there was in India a kind of brass which (being polished) could scarce be discerned from gold. This was in the natural ure[3]: but I am doubtful, whether men have sufficiently refined metals, which we count base; as whether iron, brass, or tin be refined to the height? But when they come to such a fineness as serveth the ordinary use, they try no further.

Experiment solitary touching cements and quarries.

850. There have been found certain cements under earth that are very soft; and yet, taken forth into the sun, harden as hard as marble: there are also ordinary quarries in Somersetshire, which in the quarry cut soft to any bigness, and in the building prove firm and hard.

Experiment solitary touching the altering of the colour of hairs and feathers.

851. Living creatures (generally) do change their hair with age, turning to be grey and white: as is seen in men, though some earlier, some later; in horses that are dappled, and turn white; in old squirrels that turn grisly; and many others. So do some birds; as cygnets from grey turn white; hawks from brown turn more white. And some birds there be that upon their moulting do turn colour; as robin-red-breasts, after their moulting, grow to be red again by degrees; so do goldfinches upon the head. The cause is, for that moisture doth (chiefly)

[1] The sugar-wine which Bacon here recommends is well known in Spanish America, where it is called guarapo. With respect to the wine made of honey, see Pliny xiv. 20.

[2] Arist. Mirab. 48. and 49. But the writer speaks of iron, — not of steel.

[3] So in the original. — *J. S.*

colour hair and feathers; and dryness turneth them grey and white: now hair in age waxeth drier; so do feathers. As for feathers, after moulting, they are young feathers, and so all one as the feathers of young birds. So the beard is younger than the hair of the head, and doth (for the most part) wax hoar later. Out of this ground a man may devise the means of altering the colour of birds, and the retardation of hoar hairs. But of this see in the fifth experiment.

Experiment solitary touching the differences of living creatures, male and female.

852. The difference between male and female, in some creatures, is not to be discerned, otherwise than in the parts of generation: as in horses and mares, dogs and bitches, doves he and she, and others. But some differ in magnitude, and that diversly; for in most the male is the greater; as in man, pheasants, peacocks, turkeys, and the like: and in some few, as in hawks, the female. Some differ in the hair and feathers, both in the quantity, crispation, and colours of them; as helions are hirsute, and have great manes: the shes are smooth like cats. Bulls are more crisp upon the forehead than cows; the peacock, and pheasant-cock, and goldfinch-cock, have glorious and fine colours; the hens have not. Generally the hes in birds have the fairest feathers. Some differ in divers features: as bucks have horns, does none; rams have more wreathed horns than ewes; cocks have great combs and spurs, hens little or none; boars have great fangs, sows much less; the turkey-cock hath great and swelling gills, the hen hath less: men have generally deeper and stronger voices than women. Some differ in faculty; as the cocks amongst singing-birds are the best singers. The chief cause of all these (no doubt) is, for that the males have more strength of heat than the females; which appeareth manifestly in this, that all young creatures males[1] are like females; and so are eunuchs, and gelt creatures of all kinds, liker females. Now heat causeth greatness of growth, generally, where there is moisture enough to work upon: but if there be found in any creature (which is seen rarely) an over-great heat in proportion to the moisture, in them the female is the greater; as in hawks and sparrows.

[1] That is, young male creatures. So we have *merchants strangers, letters patents*, &c. — *J. S.*

And if the heat be balanced with the moisture, then there is no difference to be seen between male and female; as in the instances of horses and dogs. We see also that the horns of oxen and cows, for the most part, are larger than the bulls; which is caused by abundance of moisture, which in the horns of the bull faileth. Again, heat causeth pilosity and crispation; and so likewise beards in men. It also expelleth finer moisture, which want of heat cannot expel; and that is the cause of the beauty and variety of feathers. Again, heat doth put forth many excrescenees, and much solid matter, which want of heat cannot do: and this is the cause of horns, and of the greatness of them; and of the greatness of the combs and spurs of cocks, gills of turkey-cocks, and fangs of boars. Heat also dilateth the pipes and organs, which causeth the deepness of the voice. Again, heat refineth the spirits, and that causeth the cock singing-bird to excel the hen.

Experiment solitary touching the comparative magnitude of living creatures.

853. There be fishes greater than any beasts; as the whale is far greater than the elephant: and beasts are (generally) greater than birds. For fishes, the cause may be, that because they live not in the air, they have not their moisture drawn and soaked by the air and sun-beams. Also they rest always in a manner, and are supported by the water; whereas motion and labour do consume. As for the greatness of beasts more than of birds, it is caused, for that beasts stay longer time in the womb than birds, and there nourish and grow; whereas in birds, after the egg laid, there is no further growth or nourishment from the female; for the sitting doth vivify, and not nourish.

Experiment solitary touching exossation of fruits.

854. We have partly touched before the means of producing fruits without cores or stones. And this we add further, that the cause must be abundance of moisture; for that the core and stone are made of a dry sap: and we see that it is possible to make a tree put forth only in blossom, without fruit; as in cherries with double flowers; much more into fruit without stone or cores. It is reported, that a scion of an apple, grafted upon a colewort-stalk, sendeth forth a great apple without a core. It is not unlikely that if the inward pith of a tree were

taken out, so that the juice came only by the bark, it would work the effect. For it hath been observed that in pollards, if the water get in on the top, and they become hollow, they put forth the more. We add also, that it is delivered for certain by some, that if the scion be grafted the small end downwards, it will make fruit have little or no cores and stones.

Experiment solitary touching the melioration of tobacco.

855. Tobacco is a thing of great price, if it be in request: for an acre of it will be worth (as is affirmed) two hundred pounds by the year towards charge.[1] The charge of making the ground and otherwise is great, but nothing to the profit. But the English tobacco hath small credit, as being too dull and earthy: nay, the Virginian tobacco, though that be in a hotter climate, can get no credit for the same cause: so that a trial to make tobacco more aromatical, and better concocted, here in England, were a thing of great profit. Some have gone about to do it by drenching the English tobacco in a decoction or infusion of Indian tobacco; but those are but sophistications and toys; for nothing that is once perfect, and hath run his race, can receive much amendment. You must ever resort to the beginnings of things for melioration. The way of maturation of tobacco must, as in other plants, be from the heat either of the earth or of the sun: we see some leading of this in musk-melons; which are sown upon a hot-bed, dunged below, upon a bank turned upon the south sun, to give heat by reflexion; laid upon tiles, which increaseth the heat; and covered with straw to keep them from cold. They remove them also, which addeth some life: and by these helps they become as good in England, as in Italy or Provence. These, and the like means, may be tried in tobacco. Inquire also of the steeping of roots in some such liquor as may give them vigour to put forth strong.

Experiment solitary touching several heats working the same effects.

856. Heat of the sun for the maturation of fruits; yea, and the heat of vivification of living creatures; are both represented

[1] In France the average yield of a hectare of tobacco was, in 1841, 1185 kilogrammes (Boussingault, Economie Rurale, vol. i. p. 435.), which is about equivalent to 1058 pounds the acre. At this rate the price in Bacon's time must have been about 3*s.* 9*d.* a pound.

and supplied by the heat of fire; and likewise the heats of the sun, and life, are represented one by the other. Trees set upon the backs of chimneys do ripen fruit sooner. Vines that have been drawn in at the window of a kitchen, have sent forth grapes ripe a month at least before others. Stoves at the back of walls bring forth oranges here with us. Eggs, as is reported by some, have been hatched in the warmth of an oven. It is reported by the ancients, that the ostrich[1] layeth her eggs under sand, where the heat of the sun discloseth them.[2]

Experiment solitary touching swelling and dilatation in boiling.

857. Barley in the boiling swelleth not much; wheat swelleth more[3]; rice extremely; insomuch as a quarter of a pint (unboiled) will arise to a pint boiled. The cause (no doubt) is, for that the more close and compact the body is, the more it will dilate: now barley is the most hollow; wheat more solid than that; and rice most solid of all. It may be also that some bodies have a kind of lentour, and more depertible nature than others; as we see it evident in coloration; for a small quantity of saffron will tinct more than a very great quantity of brasil or wine.

Experiment solitary touching the dulcoration of fruits.

858. Fruit groweth sweet by rolling, or pressing them gently with the hand; as rolling pears, damascenes, &c.: by rottenness; as medlars, services, sloes, heps, &c.: by time; as apples, wardens, pomegranates, &c.: by certain special maturations; as by laying them in hay, straw, &c.: and by fire; as in roasting, stewing, baking, &c. The cause of the sweetness by rolling and pressing, is emollition, which they properly induce; as in beating of stock-fish, flesh, &c.: by rottenness, is for that the spirits of the fruit by putrefaction gather heat, and thereby digest the harder part; for in all putrefactions there is a degree of heat: by time and keeping, is because the spirits

[1] *Estrich* in the original. — *J. S.*

[2] Conrad Gesner, who is very learned in all writers on natural history, refers for this statement to Albertus Magnus, who gives no ancient authority for it, and I have not been able to find any. The notion that the ostrich hatches her eggs by looking at them, Gesner quotes from Cælius Rhodiginus. See his *Hist. Animal.* iii. p. 711. As she is commonly taxed with want of solicitude about her offspring, it is worth mentioning that Ælian speaks of a cruel method of catching the ostrich; namely, putting a cheval de frise of spikes round her nest, on which she impales herself in endeavouring to return to her young.

[3] Arist. Prob. xxi. 22.

of the body do ever feed upon the tangible parts, and attenuate them: by several maturations is, by some degree of heat: and by fire is, because it is the proper work of heat to refine and to incorporate; and all sourness consisteth in some grossness of the body; and all incorporation doth make the mixture of the body more equal in all the parts; which ever induceth a milder taste.

Experiment solitary touching flesh edible and not edible.

859. Of fleshes, some are edible; some, except it be in famine, not. For those that are not edible, the cause is, for that they have commonly too much bitterness of taste; and therefore those creatures which are fierce and choleric are not edible; as lions, wolves, squirrels, dogs, foxes, horses, &c. As for kine, sheep, goats, deer, swine, coneys, hares, &c., we see they are mild and fearful. Yet it is true that horses, which are beasts of courage, have been and are eaten by some nations; as the Scythians were called Hippophagi; and the Chineses eat horse-flesh at this day; and some gluttons have used to have colts'-flesh baked. In birds, such as are carnivoræ, and birds of prey, are commonly no good meat; but the reason is rather the choleric nature of those birds, than their feeding upon flesh: for puets, gulls, shovellers, ducks, do feed upon flesh, and yet are good meat; and we see that those birds which are of prey, or feed upon flesh, are good meat when they are very young; as hawks, rooks out of the nest, owls, &c. Man's flesh is not eaten. The reasons are three: first, because men in humanity do abhor it: secondly, because no living creature that dieth of itself is good to eat: and therefore the cannibals themselves eat no man's-flesh of those that die of themselves, but of such as are slain: the third is, because there must be generally some disparity between the nourishment and the body nourished; and they must not be over-near, or like: yet we see that in great weaknesses and consumptions, men have been sustained with woman's milk; and Ficinus fondly (as I conceive) adviseth, for the prolongation of life, that a vein be opened in the arm of some wholesome young man, and the blood to be sucked.[1] It is said that witches do greedily eat man's flesh; which if it be true, besides

[1] Ficinus, De vitâ producendâ, ii. 11.

a devilish appetite in them, it is likely to proceed for that man's flesh may send up high and pleasing vapours, which may stir the imagination; and witches' felicity is chiefly in imagination, as hath been said.

Experiment solitary touching the salamander.

860. There is an ancient received tradition of the salamander, that it liveth in the fire, and hath force also to extinguish the fire. It must have two things, if it be true, to this operation: the one a very close skin, whereby flame, which in the midst is not so hot, cannot enter; for we see that if the palm of the hand be anointed thick with white of egg, and then aqua vitæ be poured upon it and inflamed, yet one may endure the flame a pretty while. The other is some extreme cold and quenching virtue in the body of that creature, which choketh the fire. We see that milk quencheth wild-fire better than water, because it entereth better.

Experiment solitary touching the contrary operations of time upon fruits and liquors.

861. Time doth change fruit, (as apples, pears, pomegranates, &c.) from more sour to more sweet: but contrariwise liquors, (even those that are of the juice of fruit,) from more sweet to more sour; as wort, must, new verjuice, &c. The cause is, the congregation of the spirits together: for in both kinds the spirit is attenuated by time; but in the first kind it is more diffused, and more mastered by the grosser parts, which the spirits do but digest; but in drinks the spirits do reign, and finding less opposition of the parts, become themselves more strong; which causeth also more strength in the liquor; such as if the spirits be of the hotter sort, the liquor becometh apt to burn: but in time it causeth likewise, when the higher spirits are evaporated, more sourness.

Experiment solitary touching blows and bruises.

862. It hath been observed by the ancients that plates of metal, and especially of brass, applied presently to a blow, will keep it down from swelling.[1] The cause is repercussion, without humectation or entrance of any body: for the plate hath only a virtual cold, which doth not search into the hurt; whereas all plaisters and ointments do enter. Surely the

[1] Arist. Prob. ix. 10.

cause that blows and bruises induce swellings is, for that the spirits resorting to succour the part that laboureth, draw also the humours with them; for we see that it is not the repulse and the return of the humour in the part strucken that causeth it; for that gouts and tooth-aches cause swelling, where there is no percussion at all.

Experiment solitary touching the orrice root.

863. The nature of the orrice root is almost singular; for there are but few odoriferous roots; and in those that are in any degree sweet, it is but the same sweetness with the wood or leaf: but the orrice is not sweet in the leaf: neither is the flower anything so sweet as the root. The root seemeth to have a tender dainty heat; which when it cometh above ground to the sun and the air, vanisheth: for it is a great mollifier; and hath a smell like a violet.

Experiment solitary touching the compression of liquors.

864. It hath been observed by the ancients that a great vessel full, drawn into bottles, and then the liquor put again into the vessel, will not fill the vessel again so full as it was, but that it may take in more liquor: and that this holdeth more in wine than in water.[1] The cause may be trivial; namely, by the expence of the liquor, in regard some may stick to the sides of the bottles: but there may be a cause more subtile; which is, that the liquor in the vessel is not so much compressed as in the bottle; because in the vessel the liquor meeteth with liquor chiefly; but in the bottles a small quantity of liquor meeteth with the sides of the bottles, which compress it so that it doth not open again.

Experiment solitary touching the working of water upon air contiguous.

865. Water being contiguous with air, cooleth it, but moisteneth it not, except it vapour. The cause is, for that heat and cold have a virtual transition, without communication of substance; but moisture not: and to all madefaction there is required an imbibition: but where the bodies are of such several levity and gravity as they mingle not, there can

[1] Arist. Prob. xxv. 8. For the statements in the next two paragraphs, see the third and eighteenth problems in the same section.

follow no imbibition. And therefore oil likewise lieth at the top of the water, without commixture: and a drop of water running swiftly over a straw, or smooth body, wetteth not.

Experiment solitary touching the nature of air.

866. Star-light nights, yea, and bright moonshine nights, are colder than cloudy nights. The cause is, the dryness and fine ness of the air, which thereby becometh more piercing and sharp; and therefore great continents are colder than islands: and as for the moon, though itself inclineth the air to moisture, yet when it shineth bright, it argueth the air is dry. Also close air is warmer than open air; which (it may be) is, for that the true cause of cold is an expiration from the globe of the earth, which in open places is stronger; and again, air itself, if it be not altered by that expiration, is not without some secret degree of heat; as it is not likewise without some secret degree of light; for otherwise cats and owls could not see in the night, but that air hath a little light, proportionable to the visual spirits of those creatures.

Experiments in consort touching the eyes and sight.[1]

867. The eyes do move one and the same way; for when one eye moveth to the nostril, the other moveth from the nostril. The cause is motion of consent, which in the spirits and parts spiritual is strong. But yet use will induce the contrary: for some can squint when they will; and the common tradition is, that if children be set upon a table with a candle behind them, both eyes will move outwards, as affecting to see the light, and so induce squinting.

868. We see more exquisitely with one eye shut, than with both open. The cause is, for that the spirits visual unite themselves more, and so become stronger. For you may see by looking in a glass, that when you shut one eye, the pupil of the other eye that is open dilateth.

869. The eyes, if the sight meet not in one angle, see things double. The cause is, for that seeing two things, and seeing one thing twice, worketh the same effect; and therefore a little pellet held beween two fingers laid across, seemeth double.

[1] The statements in these paragraphs, to 872. inclusive, are taken from Arist. Prob. xxxi. 7. 2. 11. 15 26. 29. and 3.

870. Pore-blind men see best in the dimmer lights; and likewise have their sight stronger near hand, than those that are not pore-blind; and can read and write smaller letters. The cause is, for that the spirits visual, in those that are pore-blind, are thinner and rarer than in others; and therefore the greater light disperseth them. For the same cause they need contracting; but being contracted, are more strong than the visual spirits of ordinary eyes are; as when we see through a level the sight is the stronger; and so is it when you gather the eye-lids somewhat close; and it is commonly seen in those that are pore-blind, that they do much gather the eye-lids together. But old men, when they would see to read, put the paper somewhat afar off; the cause is, for that old men's spirits visual, contrary to those of pore-blind men, unite not but when the object is at some good distance from their eyes.

871. Men see better, when their eyes are over against the sun or a candle, if they put their hand a little before their eyes. The reason is, for that the glaring of the sun or the candle doth weaken the eye; whereas the light circumfused is enough for the perception. For we see that an over-light maketh the eyes dazzle; insomuch as perpetual looking against the sun would cause blindness. Again, if men come out of a great light into a dark room; and contrariwise, if they come out of a dark room into a light room; they seem to have a mist before their eyes, and see worse than they shall do after they have stayed a little while either in the light or in the dark. The cause is, for that the spirits visual are, upon a sudden change, disturbed and put out of order; and till they be recollected, do not perform their function well. For when they are much dilated by light, they cannot contract suddenly; and when they are much contracted by darkness, they cannot dilate suddenly. And excess of both these (that is, of the dilatation and contraction of the spirits visual), if it be long, destroyeth the eye. For as long looking against the sun or fire hurteth the eye by dilatation; so curious painting in small volumes, and reading of small letters, do hurt the eye by contraction.

872. It hath been observed that in anger the eyes wax red; and in blushing, not the eyes, but the ears, and the parts behind them. The cause is, for that in anger the spirits ascend and wax eager; which is most easily seen in the eyes, because they are translucid; though withal it maketh both the

cheeks and the gills red; but in blushing, it is true the spirits ascend likewise to succour both the eyes and the face, which are the parts that labour; but then they are repulsed by the eyes, for that the eyes, in shame, do put back the spirits that ascend to them, as unwilling to look abroad: for no man in that passion doth look strongly, but dejectedly; and that repulsion from the eyes diverteth the spirits and heat more to the ears, and the parts by them.

873. The objects of the sight may cause a great pleasure and delight in the spirits, but no pain or great offence; except it be by memory, as hath been said. The glimpses and beams of diamonds that strike the eye; Indian feathers, that have glorious colours; the coming into a fair garden; the coming into a fair room richly furnished; a beautiful person; and the like; do delight and exhilarate the spirits much. The reason why it holdeth not in the offence is, for that the sight is the most spiritual of the senses; whereby it hath no object gross enough to offend it. But the cause (chiefly) is, for that there be no active objects to offend the eye. For harmonical sounds and discordant sounds are both active and positive: so are sweet smells and stinks: so are bitter and sweet in tastes: so are over-hot and over-cold in touch: but blackness and darkness are indeed but privatives; and therefore have little or no activity. Somewhat they do contristate, but very little.

Experiment solitary touching the colour of the sea or other water.

874. Water of the sea, or otherwise, looketh blacker when it is moved, and whiter when it resteth.[1] The cause is, for that by means of the motion, the beams of light pass not straight, and therefore must be darkened: whereas, when it resteth, the beams do pass straight. Besides, splendour hath a degree of whiteness; especially if there be a little repercussion: for a looking-glass with the steel behind, looketh whiter than glass simple. This experiment deserveth to be driven further, in trying by what means motion may hinder sight.

Experiment solitary touching shell-fish.

875. Shell-fish have been by some of the ancients compared and sorted with the insecta[2]; but I see no reason why they

[1] Arist. Prob. xxiii. 23.

[2] I believe Aristotle is alluded to. He divides the Exsanguia into four classes, of

should; for they have male and female as other fish have: neither are they bred of putrefaction; especially such as do move. Nevertheless it is certain that oysters and cockles and mussles, which move not, have no discriminate sex. *Quære*, in what time, and how they are bred? It seemeth that shells of oysters are bred where none were before; and it is tried, that the great horse-mussle with the fine shell, that breedeth in ponds, hath bred within thirty years: but then, which is strange, it hath been tried, that they do not only gape and shut as the oysters do, but remove from one place to another.

Experiment solitary touching the right side and the left.

876. The senses are alike strong both on the right side and on the left; but the limbs on the right side are stronger.[1] The cause may be, for that the brain, which is the instrument of sense, is alike on both sides; but motion and abilities of moving are somewhat holpen from the liver, which lieth on the right side. It may be also, for that the senses are put in exercise indifferently on both sides from the time of our birth; but the limbs are used most on the right side, whereby custom helpeth; for we see that some are left-handed; which are such as have used the left hand most.

Experiment solitary touching frictions.[2]

877. Frictions make the parts more fleshy and full; as we see both in men, and in currying of horses, &c. The cause is, for that they draw greater quantity of spirits and blood to the parts: and again, because they draw the aliment more forcibly from within: and again, because they relax the pores, and so make better passage for the spirits, blood, and aliment: lastly, because they dissipate and digest any inutile or excrementitious moisture which lieth in the flesh; all which help assimilation. Frictions also do more fill and impinguate the body, than exercise. The cause is, for that in frictions the inward parts are at rest; which in exercise are beaten (many times) too much: and for the same reason (as we have noted heretofore) galley-slaves are fat and fleshy, because they stir the limbs more, and the inward parts less.

which shell-fish form one, and insects another. See Arist. De Part. Animal. iv. 5. 1.; and compare Cardan, De Rer. Variet.

[1] Arist. Prob. xxxi. 13. Hippocrates asserts the contrary.

[2] See Arist. Prob. xxxvii. 3. and 6.

Experiment solitary touching globes appearing flat at distance.

878. All globes afar off appear flat.[1] The cause is, for that distance, being a secondary object of sight, is not otherwise discerned than by more or less light: which disparity when it cannot be discerned, all seemeth one: as it is (generally) in objects not distinctly discerned; for so letters, if they be so far off as they cannot be discerned, shew but as a duskish paper; and all engravings and embossings (afar off) appear plain.

Experiment solitary touching shadows.

879. The utmost parts of shadows seem ever to tremble.[2] The cause is, for that the little motes which we see in the sun do ever stir, though there be no wind; and therefore those moving, in the meeting of the light and the shadow, from the light to the shadow, and from the shadow to the light, do shew the shadow to move, because the medium moveth.

Experiment solitary touching the rolling and breaking of the seas.

880. Shallow and narrow seas break more than deep and large.[3] The cause is, for that, the impulsion being the same in both, where there is greater quantity of water, and likewise space enough, there the water rolleth and moveth both more slowly and with a sloper rise and fall: but where there is less water, and less space, and the water dasheth more against the bottom, there it moveth more swiftly, and more in precipice; for in the breaking of the waves there is ever a precipice.

Experiment solitary touching the dulcoration of salt water.

881. It hath been observed by the ancients that salt water boiled, or boiled and cooled again, is more potable than of itself raw: and yet the taste of salt in distillations by fire riseth not; for the distilled water will be fresh. The cause may be, for that the salt part of the water doth partly rise into a kind of scum on the top, and partly goeth into a sediment in the

[1] Aristotle (Prob. xvi. 7.) remarks this in the case of the sun and moon. That a luminous globe appears uniformly bright, shows that the intensity with which light radiates varies as the sine of the angle its direction makes with a normal to the radiating surface. Were this not the case, the brightness would increase indefinitely from the centre towards the circumference.

[2] Arist. Prob. xvi. 12.

[3] Id. ib. xxiii. 1. And see the eighteenth, twentieth, and twenty-first problems of the same section for the statements in the next three paragraphs.

bottom; and so is rather a separation than an evaporation. But it is too gross to rise into a vapour: and so is a bitter taste likewise; for simple distilled waters, of wormwood and the like, are not bitter.

Experiment solitary touching the return of saltness in pits upon the sea-shore.

882. It hath been set down before, that pits upon the sea-shore turn into fresh water, by percolation of the salt through the sand: but it is further noted by some of the ancients that in some places of Africk, after a time, the water in such pits will become brackish again. The cause is, for that after a time the very sands through which the salt water passeth become salt; and so the strainer itself is tincted with salt. The remedy therefore is, to dig still new pits, when the old wax brackish; as if you would change your strainer.

Experiment solitary touching attraction by similitude of substance.

883. It hath been observed by the ancients that salt water will dissolve salt put into it, in less time than fresh water will dissolve it. The cause may be, for that the salt in the precedent water doth, by similitude of substance, draw the salt new put in unto it; whereby it diffuseth in the liquor more speedily. This is a noble experiment, if it be true; for it sheweth means of more quick and easy infusions; and it is likewise a good instance of attraction by similitude of substance. Try it with sugar put into water formerly sugared, and into other water unsugared.

Experiment solitary touching attraction.

884. Put sugar into wine, part of it above, part under the wine; and you shall find (that which may seem strange) the sugar above the wine will soften and dissolve sooner than that within the wine. The cause is, for that the wine entereth that part of the sugar which is under the wine by simple infusion or spreading; but that part above the wine is likewise forced by sucking; for all spungy bodies expel the air and draw in liquor, if it be contiguous: as we see it also in spunges put part above the water. It is worthy the inquiry, to see

how you may make more accurate infusions by help of attraction.

Experiment solitary touching heat under earth.

885. Water in wells is warmer in winter than in summer; and so air in caves. The cause is, for that in the hither parts, under the earth, there is a degree of some heat (as appeareth in sulphureous veins, &c.); which shut close in (as in winter) is the more; but if it perspire (as it doth in summer), it is the less.

Experiment solitary touching flying in the air.

886. It is reported that amongst the Leucadians[1], in ancient time, upon a superstition, they did use to precipitate a man from a high cliff into the sea; tying about him with strings, at some distance, many great fowls; and fixing unto his body divers feathers, spread, to break the fall.[2] Certainly many birds of good wing (as kites, and the like,) would bear up a good weight as they fly; and spreading of feathers thin, and close and in great breadth, will likewise bear up a great weight; being even laid, without tilting upon the sides. The further extension of this experiment for flying may be thought upon.

Experiment solitary touching the dye of scarlet.

887. There is in some places, (namely in Cephalonia) a little shrub which they call holy-oak, or dwarf-oak; upon the leaves whereof there riseth a tumour like a blister; which they gather, and rub out of it a certain red dust, that converteth (after a while) into worms, which they kill with wine, (as is reported,) when they begin to quicken: with this dust they dye scarlet.[3]

Experiment solitary touching maleficiating.

888. In Zant it is very ordinary to make men impotent to accompany with their wives. The like is practised in Gascony; where it is called *nouër l'eguillette.* It is practised always upon the wedding-day. And in Zant the mothers themselves do it, by way of prevention; because thereby they hinder other charms, and can undo their own.[4] It is a thing the civil law taketh knowledge of; and therefore is of no light regard.

[1] *Leucacians* in the original. — *J. S.*
[2] This story is mentioned by Sandys, p. 4.
[3] Sandys, ubi supra.
[4] Id. p. 6.

Experiment solitary touching the rise of water by means of flame.

889. It is a common experiment, but the cause is mistaken. Take a pot, (or better a glass, because therein you may see the motion,) and set a candle lighted in the bottom of a bason of water; and turn the mouth of the pot or glass over the candle; and it will make the water rise. They ascribe it to the drawing of heat; which is not true: for it appeareth plainly to be but a motion of *nexe*, which they call *ne detur vacuum;* and it proceedeth thus. The flame of the candle, as soon as it is covered, being suffocated by the close air, lesseneth by little and little: during which time there is some little ascent of water, but not much: for the flame occupying less and less room, as it lesseneth, the water succeedeth. But upon the instant of the candle's going out, there is a sudden rise of a great deal of water: for that the body of the flame filleth no more place, and so the air and the water succeed. It worketh the same effect, if instead of water you put flour or sand into the bason: which sheweth that it is not the flame's drawing the liquor, as nourishment; as it is supposed; for all bodies are alike unto it; as it is ever in motion of nexe; insomuch as I have seen the glass, being held by the hand, hath lifted up the bason and all; the motion of nexe did so clasp the bottom of the bason. That experiment, when the bason was lifted up, was made with oil, and not with water: nevertheless this is true, that at the very first setting of the mouth of the glass upon the bottom of the bason, it draweth up the water a little, and then standeth at a stay, almost till the candle's going out, as was said. This may shew some attraction at first: but of this we will speak more, when we handle attractions by heat.

Experiments in consort touching the influences of the moon.

Of the power of the celestial bodies, and what more secret influences they have besides the two manifest influences of heat and light, we shall speak when we handle experiments touching the celestial bodies: meanwhile we will give some directions for more certain trials of the virtue and influences of the moon; which is our nearest neighbour.

The influences of the moon (most observed) are four. The drawing forth of heat; the inducing of putrefaction; the increase of moisture; the exciting of the motions of spirits.

890. For the drawing forth of heat, we have formerly prescribed to take water warm, and to set part of it against the moon-beams, and part of it with a screen between; and to see whether that which standeth exposed to the beams will not cool sooner. But because this is but a small interposition, (though in the sun we see a small shade doth much,) it were good to try it when the moon shineth, and when the moon shineth not at all; and with water warm in a glass bottle, as well as in a dish; and with cinders; and with iron red-hot, &c.

891. For the inducing of putrefaction, it were good to try it with flesh or fish exposed to the moon-beams, and again exposed to the air when the moon shineth not, for the like time; to see whether will corrupt sooner: and try it also with capon, or some other fowl, laid abroad, to see whether it will mortify and become tender sooner; try it also with dead flies, or dead worms, having a little water cast upon them, to see whether will putrefy sooner. Try it also with an apple or orange, having holes made in their tops, to see whether will rot or mould sooner. Try it also with Holland cheese, having wine put into it, whether will breed mites sooner or greater.

892. For the increase of moisture, the opinion received is that seeds will grow soonest; and hair, and nails, and hedges, and herbs cut, &c., will grow soonest; if they be set or cut in the increase of the moon. Also that brains in rabbits, woodcocks, calves, &c., are fullest in the full of the moon: and so of marrow in the bones; and so of oysters and cockles, which of all the rest are the easiest tried, if you have them in pits.

893. Take some seeds, or roots, (as onions, &c.) and set some of them immediately after the change; and others of the same kind immediately after the full: let them be as like as can be; the earth also the same as near as may be; and therefore best in pots: let the pots also stand where no rain or sun may come to them, lest the difference of the weather confound the experiment: and then see in what time the seeds set in the increase of the moon come to a certain height; and how they differ from those that are set in the decrease of the moon.

894. It is like that the brain of man waxeth moister and fuller upon the full of the moon; and therefore it were good for those that have moist brains, and are great drinkers, to take fume of lignum aloës, rosemary, frankincense, &c., about the full of the moon. It is like also, that the humours in men's bodies increase and decrease as the moon doth; and therefore, it were good to purge some day or two after the full; for that then the humours will not replenish so soon again.

895. As for the exciting of the motion of the spirits, you must note that the growth of hedges, herbs, hair, &c. is caused from the moon, by exciting of the spirits as well as by increase of the moisture. But for spirits in particular, the great instance is in lunacies.

896. There may be other secret effects of the influence of the moon, which are not yet brought into observation. It may be, that if it so fall out that the wind be north, or north-east, in the full of the moon, it increaseth cold; and if south, or south-west, it disposeth the air for a good while to warmth and rain; which would be observed.

897. It may be, that children and young cattle that are brought forth in the full of the moon, are stronger and larger than those that are brought forth in the wane; and those also which are begotten in the full of the moon: so that it might be good husbandry to put rams and bulls to their female somewhat before the full of the moon. It may be also, that the eggs laid in the full of the moon breed the better bird; and a number of the like effects which may be brought into observation. *Quære* also, whether great thunders and earthquakes be not most in the full of the moon.

Experiment solitary touching vinegar.

898. The turning of wine to vinegar is a kind of putrefaction: and in making of vinegar, they use to set vessels of wine over against the noon-sun; which calleth out the more oily spirits, and leaveth the liquor more sour and hard. We see also, that burnt wine is more hard and astringent than wine unburnt. It is said that cider, in navigations under the line, ripeneth, when wine or beer soureth. It were good to set a rundlet of verjuice over against the sun in summer, as they do vinegar, to see whether it will ripen and sweeten.

Experiment solitary touching creatures that sleep all winter.

899. There be divers creatures that sleep all winter; as the bear, the hedge-hog, the bat, the bee, &c. These all wax fat when they sleep, and egest not. The cause of their fattening during their sleeping time, may be the want of assimilating; for whatsoever assimilateth not to flesh, turneth either to sweat or fat. These creatures, for part of their sleeping time, have been observed not to stir at all; and for the other part, to stir, but not to remove. And they get warm and close places to sleep in. When the Flemings wintered in Nova Zembla[1], the bears about the middle of November went to sleep; and then the foxes began to come forth, which durst not before. It is noted by some of the ancients, that the she-bear breedeth, and lieth in with her[2] young, during that time of rest; and that a bear big with young hath seldom been seen.[3]

Experiment solitary touching the generating of creatures by copulation and by putrefaction.

900. Some living creatures are procreated by copulation between male and female; some by putrefaction: and of those which come by putrefaction, many do (nevertheless) afterwards procreate by copulation. For the cause of both generations: first, it is most certain that the cause of all vivification is a gentle and proportionable heat, working upon a glutinous and yielding substance: for the heat doth bring forth spirit in that substance; and the substance being glutinous produceth two effects; the one, that the spirit is detained, and cannot break forth; the other, that the matter being gentle and yielding, is driven forwards by the motion of the spirits, after some swelling, into shape and members. Therefore all sperm, all menstruous substance, all matter whereof creatures are produced by putrefaction, have evermore a closeness, lentour, and sequacity. It seemeth therefore, that the generation by sperm only, and by putrefaction, have two different causes. The first is, for that creatures which have a definite and exact shape (as those have which are procreated by copulation,) cannot be produced by a weak and casual heat; nor out of

[1] In 1596-97. The bears disappeared after sunset, but there was no other reason for supposing that they became dormant.

[2] *Their* in the original. — *J. S.*

[3] Arist. Hist. Animal. vi. 30., and viii. 17.

matter which is not exactly prepared according to the species. The second is, for that there is a greater time required for maturation of perfect creatures; for if the time required in vivification be of any length, then the spirit will exhale before the creature be mature; except it be enclosed in a place where it may have continuance of the heat, access of some nourishment to maintain it, and closeness that may keep it from exhaling: and such places are the wombs and matrices of the females.[1] And therefore all creatures made of putrefaction are of more uncertain shape; and are made in shorter time; and need not so perfect an inclosure, though some closeness be commonly required. As for the Heathen opinion, which was, that upon great mutations of the world, perfect creatures were first engendered of concretion; as well as frogs, and worms, and flies, and such like, are now[2]; we know it to be vain: but if any such thing should be admitted, discoursing according to sense, it cannot be, except you admit a chaos first, and commixture of heaven and earth. For the frame of the world, once in order, cannot effect it by any excess or casualty.

[1] Compare Telesius, De Rerum Naturâ, vi.
[2] Plut. De Placitis Philos. v. 19.

NATURAL HISTORY.

CENTURY X.

Experiments in consort touching transmission and influx of immateriate virtues, and the force of imagination.

THE philosophy of Pythagoras (which was full of superstition) did first plant a monstrous imagination; which afterwards was, by the school of Plato and others, watered and nourished. It was, that the world was one entire perfect living creature; insomuch as Apollonius of Tyana, a Pythagorean prophet, affirmed that the ebbing and flowing of the sea was the respiration of the world, drawing in water as breath, and putting it forth again.[1] They went on and inferred, that if the world were a living creature, it had a soul and spirit; which also they held, calling it *spiritus mundi*, the spirit or soul of the world: by which they did not intend God (for they did admit of a deity besides), but only the soul or essential form of the universe. This foundation being laid, they might build upon it what they would; for in a living creature, though never so great, (as for example, in a great whale,) the sense and the affects of any one part of the body instantly make a transcursion throughout the whole body: so that by this they did insinuate, that no distance of place, nor want or indisposition of matter, could hinder magical operations; but that (for example) we might here in Europe have sense and feeling of that which was done in China; and likewise we might work any effect without and

[1] Philostratus, Vit. Apollon. v. 1.

against matter; and this not holpen by the co-operation of angels or spirits, but only by the unity and harmony of nature. There were some also that stayed not here; but went further, and held that if the spirit of man (whom they call the microcosm) do give a fit touch to the spirit of the world by strong imaginations and beliefs, it might command nature; for Paracelsus, and some darksome authors of magic, do ascribe to imagination exalted, the power of miracle-working faith. With these vast and bottomless follies men have been (in part) entertained.

But we, that hold firm to the works of God, and to the sense, which is God's lamp, (*lucerna Dei spiraculum hominis,*) will inquire with all sobriety and severity, whether there be to be found in the footsteps of nature any such transmission and influx of immateriate virtues; and what the force of imagination is, either upon the body imaginant or upon another body; wherein it will be like that labour of Hercules in purging the stable of Augeas, to separate from superstitious and magical arts and observations, any thing that is clean and pure natural, and not to be either contemned or condemned. And although we shall have occasion to speak of this in more places than one, yet we will now make some entrance thereinto.

Experiments in consort, monitory, touching transmission of spirits and the force of imagination.

901. Men are to be admonished that they do not withdraw credit from the operations by transmission of spirits and force of imagination, because the effects fail sometimes. For as in infection and contagion from body to body (as the plague and the like) it is most certain that the infection is received (many times) by the body passive, but yet is by the strength and good disposition thereof repulsed and wrought out, before it be formed into a disease; so much more in impressions from mind to mind, or from spirit to spirit, the impression taketh, but is encountered and overcome by the mind and spirit, which is passive, before it work any manifest effect. And therefore they work most upon weak minds and spirits; as those of women, sick persons, superstitious and fearful persons, children and young creatures.

Nescio quis teneros oculus mihi fascinat agnos.[1]

The poet speaketh not of sheep, but of lambs. As for the weakness of the power of them upon kings and magistrates, it may be ascribed (besides the main, which is the protection of God over those that execute his place) to the weakness of the imagination of the imaginant: for it is hard for a witch or a sorcerer to put on a belief that they can hurt such persons.

902. Men are to be admonished, on the other side, that they do not easily give place and credit to these operations, because they succeed many times. For the cause of this success is oft to be truly ascribed unto the force of affection and imagination upon the body agent; and then by a secondary means it may work upon a divers body: as for example, if a man carry a planet's seal, or a ring, or some part of a beast, believing strongly that it will help him to obtain his love, or to keep him from danger of hurt in fight, or to prevail in a suit, &c., it may make him more active and industrious, and again more confident and persisting, than otherwise he would be. Now the great effects that may come of industry and perseverance (especially in civil business) who knoweth not? For we see audacity doth almost bind and mate the weaker sort of minds; and the state of human actions is so variable, that to try things oft, and never to give over, doth wonders: therefore it were a mere fallacy and mistaking to ascribe that to the force of imagination upon another body, which is but the force of imagination upon the proper body; for there is no doubt but that imagination and vehement affection work greatly upon the body of the imaginant; as we shall shew in due place.

903. Men are to be admonished that, as they are not to mistake the causes of these operations, so much less they are to mistake the fact or effect; and rashly to take that for done which is not done. And therefore, as divers wise judges have prescribed and cautioned, men may not too rashly believe the confessions of witches, nor yet the evidence against them. For the witches themselves are imaginative, and believe oft-times they do that which they do not: and people are credulous in that point, and ready to impute accidents and natural operations to witchcraft. It is worthy the observing, that both in ancient and late times (as in the Thessalian witches, and the meetings of

[1] Virg. Eclog. iii. 103.

witches that have been recorded by so many late confessions) the great wonders which they tell, of carrying in the air, transforming themselves into other bodies, &c., are still reported to be wrought, not by incantations or ceremonies, but by ointments, and anointing themselves all over. This may justly move a man to think that these fables are the effects of imagination: for it is certain that ointments do all (if they be laid on any thing thick) by stopping of the pores, shut in the vapours, and send them to the head extremely. And for the particular ingredients of those magical ointments, it is like they are opiate and soporiferous. For anointing of the forehead, neck, feet, back-bone, we know is used for procuring dead sleeps: and if any man say that this effect would be better done by inward potions; answer may be made, that the medicines which go to the ointments are so strong, that if they were used inwards they would kill those that use them: and therefore they work potently, though outwards.

We will divide the several kinds of the operations by transmission of spirits and imagination; which will give no small light to the experiments that follow. All operations by transmission of spirits and imagination, have this; that they work at distance, and not at touch; and they are these, being distinguished.

904. The first is the transmission or emission of the thinner and more airy parts of bodies; as in odours and infections; and this is, of all the rest, the most corporeal. But you must remember withal, that there be a number of those emissions, both wholesome and unwholesome, that give no smell at all: for the plague, many times, when it is taken, giveth no scent at all: and there be many good and healthful airs, that do appear by habitation and other proofs, that differ not in smell from other airs. And under this head you may place all imbibitions of air, where the substance is material, odour-like; whereof some nevertheless are strange, and very suddenly diffused; as the alteration which the air receiveth in Egypt, almost immediately, upon the rising of the river of Nilus, whereof we have spoken.

905. The second is the transmission or emission of those things that we call spiritual species: as visibles and sounds; the one whereof we have handled, and the other we shall

handle in due place. These move swiftly, and at great distance; but then they require a medium well disposed, and their transmission is easily stopped.

906. The third is the emissions which cause attraction of certain bodies at distance; wherein though the loadstone be commonly placed in the first rank, yet we think good to except it, and refer it to another head: but the drawing of amber and jet, and other electric bodies; and the attraction in gold of the spirit of quicksilver, at distance; and the attraction of heat at distance; and that of fire to naphtha; and that of some herbs to water, though at distance; and divers others; we shall handle, but yet not under this present title, but under the title of attraction in general.

907. The fourth is the emission of spirits, and immateriate powers and virtues, in those things which work by the universal configuration and sympathy of the world; not by forms, or celestial influxes (as is vainly taught and received), but by the primitive nature of matter, and the seeds of things. Of this kind is (as we yet suppose) the working of the load-stone, which is by consent with the globe of the earth: of this kind is the motion of gravity, which is by consent of dense bodies with the globe of the earth: of this kind is some disposition of bodies to rotation, and particularly from east to west: of which kind we conceive the main float and refloat of the sea is, which is by consent of the universe, as part of the diurnal motion. These immateriate virtues have this property differing from others; that the diversity of the medium hindereth them not; but they pass through all mediums; yet at determinate distances. And of these we shall speak, as they are incident to several titles.

908. The fifth is the emissions of spirits; and this is the principal in our intention to handle now in this place; namely, the operation of the spirits of the mind of man upon other spirits: and this is of a double nature; the operations of the affections, if they be vehement; and the operation of the imagination, if it be strong. But these two are so coupled, as we shall handle them together: for when an envious or amorous aspect doth infect the spirits of another, there is joined both affection and imagination.

909. The sixth is the influxes of the heavenly bodies, besides those two manifest ones, of heat and light. But these we will handle, where we handle the celestial bodies and motions.

910.[1] The seventh is the operations of sympathy; which the writers of natural magic have brought into an art or precept: and it is this; that if you desire to super-induce any virtue or disposition upon a person, you should take the living creature in which that virtue is most eminent and in perfection: of that creature you must take the parts wherein that virtue chiefly is collocate: again, you must take those parts in the time and act when that virtue is most in exercise: and then you must apply it to that part of man wherein that virtue chiefly consisteth. As if you would super-induce courage and fortitude, take a lion or a cock: and take the heart, tooth, or paw of the lion; or the heart or spur of the cock: take those parts immediately after the lion or the cock have been in fight: and let them be worn on a man's heart or wrist. Of these and such like sympathies, we shall speak under this present title.

911. The eighth and last is an emission of immateriate virtues; such as we are a little doubtful to propound, it is so prodigious, but that it is so constantly avouched by many: and we have set it down as a law to ourselves, to examine things to the bottom; and not to receive upon credit, or reject upon improbabilities, until there hath passed a due examination. This is, the sympathy of individuals; for as there is a sympathy of species, so (it may be) there is a sympathy of individuals: that is, that in things, or the parts of things, that have been once contiguous or entire, there should remain a transmission of virtue from the one to the other: as between the weapon and the wound. Whereupon is blazed abroad the operation of *unguentum teli:* and so of a piece of lard, or stick of elder, &c., that if part of it be consumed or putrefied, it will work upon the other part severed. Now we will pursue the instances themselves.

Experiments in consort touching emission of spirits in vapour or exhalation, odour-like.

912. The plague is many times taken without manifest sense, as hath been said. And they report that, where it is found, it hath a scent of the smell of a mellow apple; and (as some say) of May-flowers: and it is also received that smells of flowers that are mellow and luscious, are ill for the plague; as white lilies, cowslips, and hyacinths.

[1] Compare Porta, Nat. Mag. l. 12.

913. The plague is not easily received by such as continually are about them that have the plague; as keepers of the sick, and physicians: nor again by such as take antidotes, either inward, (as mithridate; juniper-berries; rue, leaf and seed, &c.,) or outward, (as angelica, zedoary, and the like, in the mouth; tar, galbanum, and the like, in perfume); nor again by old people, and such as are of a dry and cold complexion. On the other side, the plague taketh soonest hold of those that come out of a fresh air, and of those that are fasting, and of children; and it is likewise noted to go in a blood, more than to a stranger.

914. The most pernicious infection, next the plague, is the smell of the jail, when prisoners have been long and close and nastily kept; whereof we have had in our time experience twice or thrice; when both the judges that sat upon the jail, and numbers of those that attended the business or were present, sickened upon it, and died. Therefore it were good wisdom, that in such cases the jail were aired before they be brought forth.[1]

915. Out of question, if such foul smells be made by art and by the hand, they consist chiefly of man's flesh or sweat putrefied; for they are not those stinks which the nostrils straight abhor and expel, that are most pernicious; but such airs as have some similitude with man's body; and so insinuate themselves, and betray the spirits. There may be great danger in using such compositions, in great meetings of people within houses; as in churches, at arraignments, at plays and solemnities, and the like: for poisoning of air is no less dangerous than poisoning of water, which hath been used by the Turks in the wars, and was used by Emmanuel Comnenus towards the Christians, when they passed through his country to the Holy Land.[2] And these empoisonments of air are the more dangerous in meetings of people, because the much breath of people doth further the reception of the infection; and therefore, where any such thing is feared, it were good those public places were perfumed, before the assemblies.

[1] A memorable instance of what Bacon here mentions took place in 1750, in consequence of a neglected state of Newgate.

[2] I have not been able to find any authority for this statement. All the original historians of the second Crusade speak of the treachery of Comnenus, but no one charges him with having poisoned the wells. Nicetas affirms that in order to poison the Crusaders, lime was put into the flour with which they were supplied. He does not, however, assert that this was done by the emperor's direction.

916. The empoisonment of particular persons by odours, hath been reported to be in perfumed gloves, or the like: and it is like they mingle the poison that is deadly, with some smells that are sweet, which also maketh it the sooner received. Plagues also have been raised by anointings of the chinks of doors, and the like[1]; not so much by the touch, as for that it is common for men, when they find any thing wet upon their fingers, to put them to their nose; which men therefore should take heed how they do. The best is, that these compositions of infectious airs cannot be made without danger of death to them that make them. But then again, they may have some antidotes to save themselves; so that men ought not to be secure of it.

917. There have been in divers countries great plagues, by the putrefaction of great swarms of grasshoppers and locusts, when they have been dead and cast upon heaps.

918. It happeneth oft in mines, that there are damps which kill, either by suffocation, or by the poisonous nature of the mineral: and those that deal much in refining, or other works about metals and minerals, have their brains hurt and stupefied by the metalline vapours. Amongst which it is noted that the spirits of quicksilver either fly to the skull, teeth, or bones; insomuch as gilders use to have a piece of gold in their mouth, to draw the spirits of quicksilver; which gold afterwards they find to be whitened. There are also certain lakes and pits, such as that of Avernus, that poison birds (as is said) which fly over them or men that stay too long about them.

919. The vapour of charcoal, or sea-coal, in a close room, hath killed many; and it is the more dangerous, because it cometh without any ill smell, but stealeth on by little and little, inducing only a faintness, without any manifest strangling. When the Dutchmen wintered at Nova Zembla, and that they could gather no more sticks, they fell to make fire of some sea-coal they had, wherewith (at first) they were much

[1] See on this subject Manzoni's *Storia della Colonna infame.* In 1630 many persons at Milan were tortured and put to death in consequence of a popular belief that the plague, which raged in that year, had been raised in the manner mentioned in the text. For an earlier instance of the same belief, see Wierus *De Præstigiis Dæmonum.* It seems to be of recent origin, as, although the Jews were charged with producing the great plague of the fourteenth century, I have not met with any mention of their having been supposed to do so by poisonous anointings.

refreshed; but a little after they had sat[1] about the fire, there grew a general silence and lothness to speak amongst them; and immediately after, one of the weakest of the company fell down in a swoon; whereupon they doubting what it was, opened their door to let in air, and so saved themselves. The effect (no doubt) is wrought by the inspissation of the air; and so of the breath and spirits. The like ensueth in rooms newly plastered, if a fire be made in them; whereof no less man than the Emperor Jovinianus died.[2]

920. Vide the experiment 803., touching the infectious nature of the air, upon the first showers after long drought.

921. It hath come to pass that some apothecaries, upon stamping of coloquintida, have been put into a great scouring by the vapour only.

922. It hath been a practice to burn a pepper they call Ginny-pepper[3]; which hath such a strong spirit, that it provoketh a continual sneezing in those that are in the room.

923. It is an ancient tradition that blear-eyes infect sound eyes; and that a menstruous woman looking upon a glass, doth rust it[4]: nay, they have an opinion which seemeth fabulous; that menstruous women going over a field or garden, do corn and herbs good by killing the worms.[5]

924. The tradition is no less ancient, that the basilisk killeth by aspect; and that the wolf, if he see a man first, by aspect striketh a man hoarse.[6]

925. Perfumes convenient do dry and strengthen the brain, and stay rheums and defluxions; as we find in fume of rosemary dried, and lignum aloës, and calamus, taken at the mouth and nostrils: and no doubt there be other perfumes that do moisten and refresh, and are fit to be used in burning agues, consumptions, and too much wakefulness: such as are rose-water, vinegar, lemon-pills, violets, the leaves of vines sprinkled with a little rose-water, &c.

926. They do use in sudden faintings and swoonings to put

[1] *Sit* in the original. — *J. S.*

[2] Ammianus Marcellinus mentions three causes which had been assigned for the death of Jovianus, whom Bacon calls Jovinianus, — one being a tumour in the head arising from exposure to a large fire. It does not seem therefore that he was suffocated. (Ammianus Marcel. xxv. sub fin.) I may remark that there appears to be no good foundation for the common anecdote that Philip the Third of Spain died from a similar cause.

[3] Guiana pepper, *i. e.* red pepper? Guinea pigs ought, it is said, to be called Guiana pigs. They are natives, not of Africa, but of America.

[4] Arist. Prob. viii. 4., and De Insomniis, 2.

[5] Pliny, xxviii. 23.

[6] Ib. viii. 33. and 34.

a handkerchief with rose-water, or a little vinegar, to the nose; which gathereth together again the spirits, which are upon point to resolve and fall away.

927. Tobacco comforteth the spirits, and dischargeth weariness; which it worketh partly by opening; but chiefly by the opiate virtue, which condenseth the spirits. It were good therefore to try the taking of fumes by pipes (as they do in tobacco) of other things; as well to dry and comfort, as for other intentions. I wish trial be made of the drying fume of rosemary, and lignum aloës, before-mentioned, in pipe; and so of nutmeg, and folium indum, &c.

928. The following of the plough hath been approved for refreshing the spirits and procuring appetite[1]; but to do it in the ploughing for wheat or rye, is not so good; because the earth hath spent her sweet breath in vegetables put forth in summer. It is better therefore to do it when you sow barley. But because ploughing is tied to seasons, it is best to take the air of the earth new turned up, by digging with the spade, or standing by him that diggeth. Gentlewomen may do themselves much good by kneeling upon a cushion and weeding. And these things you may practise in the best seasons; which is ever the early spring, before the earth putteth forth the vegetables; and in the sweetest earth you can choose. It would be done also when the dew is a little off the ground, lest the vapour be too moist. I knew a great man that lived long, who had a clean clod of earth brought to him every morning as he sate in his bed: and he would hold his head over it a good pretty while. I commend also, sometimes, in digging of new earth, to pour in some Malmsey or Greek[2] wine; that the vapour of the earth and wine together may comfort the spirits the more; provided always it be not taken for a heathen sacrifice, or libation to the earth.

929. They have, in physic, use of pomanders, and knots of powders, for drying of rheums, comforting of the heart, provoking of sleep, &c. For though those things be not so strong as perfumes, yet you may have them continually in your hand;

[1] It is difficult to say to what the good effect, if it exists, is to be ascribed; as the air contained in the interstices of vegetable mould contains much more than the usual proportion of carbonic acid gas, and a smaller proportion of oxygen.

[2] The name Malmsey has been given to wine grown in various places, but the original Malmsey came from Malvisia in the Morea. Malmsey is of course a corruption from Malvisia.

whereas perfumes you can take but at times; and besides, there be divers things that breathe better of themselves, than when they come to the fire; as nigella romana, the seed of melanthium, amomum, &c.

930. There be two things which (inwardly used) do cool and condense the spirits; and I wish the same to be tried outwardly in vapours. The one is nitre, which I would have dissolved in Malmsey, or Greek wine, and so the smell of the wine taken; or if you would have it more forcible, pour of it upon a fire-pan, well heated, as they do rose-water and vinegar. The other is the distilled water of wild poppy, which I wish to be mingled, at half, with rose-water, and so taken with some mixture of a few cloves in a perfuming-pan. The like would be done with the distilled water of saffron flowers.

931. Smells of musk, and amber, and civet, are thought to further venereous appetite; which they may do by the refreshing and calling forth of the spirits.

932. Incense and nidorous smells (such as were of sacrifices) were thought to intoxicate the brain, and to dispose men to devotion: which they may do by a kind of sadness, and contristation of the spirits; and partly also by heating and exalting them. We see that amongst the Jews the principal perfume of the sanctuary was forbidden all common uses.[1]

933. There be some perfumes prescribed by the writers of natural magic, which procure pleasant dreams; and some others (as they say) that procure prophetical dreams; as the seeds of flax, fleawort, &c.

934. It is certain that odours do, in a small degree, nourish; especially the odour of wine: and we see men a hungered do love to smell hot bread. It is related that Democritus, when he lay a dying, heard a woman in the house complain that she should be kept from being at a feast and solemnity, (which she much desired to see,) because there would be a corpse in the house; whereupon he caused loaves of new bread to be sent for, and opened them, and poured a little wine into them; and so kept himself alive with the odour of them, till the feast was past.[2] I knew a gentleman that would fast (sometimes) three or four, yea five days, without meat, bread, or drink; but the same man used to have continually a great wisp of herbs that

[1] Exodus, xxx. 37.

[2] See for this story Diogenes Laertius, ix. 343.

he smelled on: and amongst those herbs, some esculent herbs of strong scent; as onions, garlic, leeks, and the like.

935. They do use, for the accident of the mother[1], to burn feathers and other things of ill odour; and by those ill smells the rising of the mother is put down.

936. There be airs which the physicians advise their patients to remove unto, in consumptions or upon recovery of long sicknesses: which (commonly) are plain champaigns, but grazing, and not overgrown with heath or the like; or else timber-shades, as in forests and the like. It is noted also, that groves of bays do forbid pestilent airs; which was accounted a great cause of the wholesome air of Antiochia. There be also some soils that put forth odorate herbs of themselves; as wild thyme, wild marjoram, pennyroyal, camomile; and in which the briar-roses smell almost like musk-roses; which no doubt are signs that do discover an excellent air.

937. It were good for men to think of having healthful air in their houses; which will never be if the rooms be low-roofed, or full of windows and doors; for the one maketh the air close, and not fresh; and the other maketh it exceeding unequal; which is a great enemy to health. The windows also should not be high up to the roof, (which is in use for beauty and magnificence,) but low. Also stone-walls are not wholesome; but timber is more wholesome; and especially brick. Nay, it hath been used by some with great success to make their walls thick, and to put a lay of chalk between the bricks, to take away all dampishness.

Experiment solitary touching the emissions of spiritual species which affect the senses.

938. These emissions (as we said before) are handled, and ought to be handled, by themselves under their proper titles; that is, visibles and audibles, each apart: in this place it shall suffice to give some general observations common to both. First, they seem to be incorporeal. Secondly, they work swiftly. Thirdly, they work at large distances. Fourthly, in curious varieties. Fifthly, they are not effective of any thing, nor leave no work behind them; but are energies

[1] Id est, hysteria. The use of the word mother in this sense appears to have arisen from a mistranslation of the Italian or Spanish *madre*, which represents the Latin *matrix*, as well as *mater*. Mother of pearl has probably a similar origin.

merely: for their working upon mirrors, and places of echo, doth not alter anything in those bodies: but it is the same action with the original, only repercussed. And as for the shaking of windows, or rarefying the air by great noises; and the heat caused by burning-glasses; they are rather concomitants of the audible and visible species, than the effects of them. Sixthly, they seem to be of so tender and weak a nature, as they affect only such a rare and attenuate substance as is the spirit of living creatures.

Experiments in consort touching emission of immateriate virtues from the minds and spirits of men, either by affections, or by imaginations, or by other impressions.

939. It is mentioned in some stories, that where children have been exposed, or taken away young from their parents, and that afterwards they have approached to their parents' presence, the parents (though they have not known them) have had a secret joy or other alteration thereupon.

940. There was an Egyptian soothsayer, that made Antonius believe that his genius (which otherwise was brave and confident) was, in the presence of Octavianus Cæsar, poor and cowardly: and therefore he advised him to absent himself as much as he could, and remove far from him. This soothsayer was thought to be suborned by Cleopatra, to make him live in Egypt, and other remote places from Rome.[1] Howsoever the conceit of a predominant or mastering spirit of one man over another is ancient, and received still, even in vulgar opinion.

941. There are conceits that some men, that are of an ill and melancholy nature, do incline the company into which they come to be sad and ill-disposed; and contrariwise, that others, that are of a jovial nature, do dispose the company to be merry and cheerful. And again, that some men are lucky to be kept company with and employed; and others unlucky. Certainly it is agreeable to reason, that there are at the least some light effluxions from spirit to spirit, when men are in presence one with another, as well as from body to body.

942. It hath been observed that old men who have loved young company and been conversant continually with them, have been of long life; their spirits (as it seemeth) being recreated by such company. Such were the ancient sophists and rhetoricians; which ever had young auditors and disciples;

[1] Plut. in Ant. p. 930.

as Gorgias, Protagoras, Isocrates, &c., who lived till they were an hundred years old. And so likewise did many of the grammarians and school-masters; such as was Orbilius[1], &c.

943. Audacity and confidence doth, in civil business, so great effects, as a man may reasonably doubt that, besides the very daring and earnestness and persisting and importunity, there should be some secret binding and stooping of other men's spirits to such persons.

944. The affections (no doubt) do make the spirits more powerful and active; and especially those affections which draw the spirits into the eyes: which are two: love, and envy, which is called *oculus malus*. As for love, the Platonists (some of them) go so far as to hold that the spirit of the lover doth pass into the spirits of the person loved[2]; which causeth the desire of return into the body whence it was emitted: whereupon followeth that appetite of contact and conjunction which is in lovers. And this is observed likewise, that the aspects that procure love, are not gazings, but sudden glances and dartings of the eye. As for envy, that emitteth some malign and poisonous spirit, which taketh hold of the spirit of another; and is likewise of greatest force when the cast of the eye is oblique. It hath been noted also, that it is most dangerous when an envious eye is cast upon persons in glory and triumph and joy: the reason whereof is, for that at such times the spirits come forth most into the outward parts, and so meet the percussion of the envious eye more at hand: and therefore it hath been noted, that after great triumphs, men have been ill-disposed for some days following. We see the opinion of fascination is ancient, for both effects: of procuring love, and sickness caused by envy: and fascination is ever by the eye. But yet if there be any such infection from spirit to spirit, there is no doubt but that it worketh by presence, and not by the eye alone; yet most forcibly by the eye.

945. Fear and shame are likewise infective; for we see that the starting of one will make another ready to start: and when one man is out of countenance in a company, others do likewise blush in his behalf.

Now we will speak of the force of imagination upon other bodies, and of the means to exalt and strengthen it.

[1] Sueton. De Illust. Grammat. c. 9.

[2] *τὴν ψυχὴν, Ἀγάθωνα φιλῶν, ἐπὶ χείλεσιν ἔσχον·*
ἦλθε γὰρ ἡ ταλαίη ὡς διαβησομένη. PLATO, ap. Aul. Gellium.

Imagination in this place I understand to be, the representation of an individual thought. Imagination, is of three kinds: the first joined with belief of that which is to come: the second joined with memory of that which is past: and the third is of things present, or as if they were present; for I comprehend in this, imaginations feigned and at pleasure; as if one should imagine such a man to be in the vestments of a Pope, or to have wings. I single out, for this time, that which is with faith or belief of that which is to come. The inquisition of this subject in our way (which is by induction) is wonderful hard: for the things that are reported are full of fables; and new experiments can hardly be made but with extreme caution, for the reason which we will hereafter declare.

The power of imagination is in three kinds: the first upon the body of the imaginant, including likewise the child in the mother's womb; the second is, the power of it upon dead bodies, as plants, wood, stone, metal, &c.; the third is, the power of it upon the spirits of men and living creatures: and with this last we will only meddle.

The problem therefore is, whether a man constantly and strongly believing that such a thing shall be, (as that such an one will love him, or that such an one will grant him his request, or that such an one shall recover a sickness, or the like,) it doth help any thing to the effecting of the thing itself. And here again we must warily distinguish; for it is not meant (as hath been partly said before) that it should help by making a man more stout, or more industrious; (in which kind constant belief doth much;) but merely by a secret operation, or binding, or changing the spirit of another: and in this it is hard (as we began to say) to make any new experiment; for I cannot command myself to believe what I will, and so no trial can be made. Nay, it is worse; for whatsoever a man imagineth doubtingly, or with fear, must needs do hurt, if imagination have any power at all; for a man representeth that oftener that he feareth, than the contrary.

The help therefore is, for a man to work by another, in whom he may create belief, and not by himself; until him-

self have found by experience, that imagination doth prevail; for then experience worketh in himself belief; if the belief that such a thing shall be, be joined with a belief that his imagination may procure it.

946. For example: I related one time to a man that was curious and vain enough in these things, that I saw a kind of juggler, that had a pair of cards, and would tell a man what card he thought. This pretended learned man told me it was a mistaking in me; "for," said he, "it was not the knowledge of the man's thought, (for that is proper to God,) but it was the enforcing of a thought upon him, and binding his imagination by a stronger, that he could think no other card." And thereupon he asked me a question or two, which I thought he did but cunningly, knowing before what used to be the feats of the juggler. "Sir," said he, "do you remember whether he told the card the man thought, himself, or bade another to tell it?" I answered (as was true) that he bade another tell it. Whereunto he said, "So I thought: for," said he, "himself could not have put on so strong an imagination; but by telling the other the card (who believed that the juggler was some strange man, and could do strange things) that other man caught a strong imagination." I hearkened unto him, thinking for a vanity he spoke prettily. Then he asked me another question: saith he, "Do you remember, whether he bade the man think the card first, and afterwards told the other man in his ear, what he should think; or else that he did whisper first in the man's ear that should tell the card, telling that such a man should think such a card, and after bade the man think a card?" I told him, as was true, that he did first whisper the man in the ear, that such a man should think such a card. Upon this the learned man did much exult and please himself, saying; "Lo, you may see that my opinion is right: for if the man had thought first, his thought had been fixed; but the other imagining first, bound his thought." Which though it did somewhat sink with me, yet I made it lighter than I thought, and said, "I thought it was confederacy between the juggler and the two servants:" though indeed I had no reason so to think; for they were both my father's servants, and he had never played in the house before.[1] The juggler also did

[1] The psychology, if it may be so called, of juggling is an exceedingly curious matter. The common explanation of tricks of the kind of that described in the

cause a garter to be held up, and took upon him to know that such an one should point in such a place of the garter; as it should be near so many inches to the longer end, and so many to the shorter; and still he did it, by first telling the imaginer, and after bidding the actor think.

Having told this relation, not for the weight thereof, but because it doth handsomely open the nature of the question, I return to that I said; that experiments of imagination must be practised by others, and not by a man's self. For there be three means to fortify belief: the first is experience; the second is reason; and the third is authority: and that of these which is far the most potent, is authority; for belief upon reason or experience will stagger.

947. For authority, it is of two kinds; belief in an art, and belief in a man. And for things of belief in an art, a man may exercise them by himself; but for belief in a man, it must be by another. Therefore if a man believe in astrology, and find a figure prosperous; or believe in natural magic, and that a ring with such a stone, or such a piece of a living creature, carried, will do good; it may help his imagination; but the belief in a man is far the more active. But howsoever, all authority must be out of a man's self, turned (as was said) either upon an art, or upon a man; and where authority is from one man to another, there the second must be ignorant, and not learned, or full of thoughts; and such are (for the most part) all witches and superstitious persons; whose beliefs, tied to their teachers and traditions, are no whit controlled either by reason or experience; and upon the same reason, in magic, they use (for the most part) boys and young people; whose spirits easiliest take belief and imagination.

Now to fortify imagination, there be three ways: the authority whence the belief is derived; means to quicken and corroborate the imagination; and means to repeat it and refresh it.

text,—namely, that the juggler forces a particular card on the person who is to choose, and that the latter remains unconscious of the compulsion put upon him, is, I suppose, correct. Bacon speaks only of thinking of a card, not of drawing one from the pack; but as the juggler had with him a pair (or pack) of cards, it may be presumed that the thought was manifested in an overt act. So, too, in the garter trick.

948. For the authority, we have already spoken. As for the second, namely the means to quicken and corroborate the imagination; we see what hath been used in magic (if there be in those practices any thing that is purely natural); as vestments; characters; words; seals; some parts of plants, or living creatures; stones; choice of the hour; gestures and motions; also incenses and odours; choice of society, which increaseth imagination; diets and preparations for some time before. And for words, there have been ever used either barbarous words, of no sense, lest they should disturb the imagination; or words of similitude, that may second and feed the imagination: and this was ever as well in heathen charms as in charms of latter times. There are used also Scripture words; for that the belief that religious texts and words have power, may strengthen the imagination. And for the same reason, Hebrew words (which amongst us is counted the holy tongue, and the words more mystical) are often used.

949. For the refreshing of the imagination (which was the third means of exalting it), we see the practices of magic; as in images of wax, and the like, that should melt by little and little; or some other things buried in muck, that should putrefy by little and little; or the like: for so oft as the imaginant doth think of those things, so oft doth he represent to his imagination the effect of that he desireth.

950. If there be any power in imagination, it is less credible that it should be so incorporeal and immateriate a virtue, as to work at great distances, or through all mediums, or upon all bodies; but that the distance must be competent, the medium not adverse, and the body apt and proportionate. Therefore if there be any operation upon bodies in absence by nature, it is like to be conveyed from man to man, as fame is; as if a witch by imagination should hurt any afar off, it cannot be naturally, but by working upon the spirit of some that cometh to the witch; and from that party upon the imagination of another; and so upon another; till it come to one that hath resort to the party intended; and so by him to the party intended himself. And although they speak, that it sufficeth to take a point, or a piece of the garment, or the name of the party, or the like; yet there is less credit to be given to those things, except it be by working of evil spirits.

The experiments which may certainly demonstrate the power of imagination upon other bodies, are few or none: for the experiments of witchcraft are no clear proofs; for that they may be by a tacit operation of malign spirits. We shall therefore be forced in this inquiry to resort to new experiments; wherein we can give only directions of trials, and not any positive experiments. And if any man think that we ought to have stayed till we had made experiment of some of them ourselves, (as we do commonly in other titles,) the truth is, that these effects of imagination upon other bodies have so little credit with us, as we shall try them at leisure: but in the mean time we will lead others the way.

951. When you work by the imagination of another, it is necessary that he by whom you work have a precedent opinion of you that you can do strange things, or that you are a man of art, as they call it; for else the simple affirmation to another that this or that shall be, can work but a weak impression in his imagination.

952. It were good, because you cannot discern fully of the strength of imagination in one man more than another, that you did use the imagination of more than one; that so you may light upon a strong one. As if a physician should tell three or four of his patients' servants, that their master shall surely recover.

953. The imagination of one that you shall use (such is the variety of men's minds) cannot be always alike constant and strong; and if the success follow not speedily, it will faint and leese strength. To remedy this, you must pretend to him whose imagination you use, several degrees of means by which to operate; as to prescribe him that every three days, if he find not the success apparent, he do use another root, or part of a beast, or ring, &c., as being of more force; and if that fail, another; and if that, another; till seven times. Also you must prescribe a good large time for the effect you promise; as if you should tell a servant of a sick man that his master shall recover, but it will be fourteen days ere he findeth it apparently, &c. All this to entertain the imagination, that it waver less.

954. It is certain that potions, or things taken into the body; incenses and perfumes taken at the nostrils; and oint-

ments of some parts; do (naturally) work upon the imagination of him that taketh them. And therefore it must needs greatly cooperate with the imagination of him whom you use, if you prescribe him, before he do use the receipt for the work which he desireth, that he do take such a pill, or a spoonful of liquor; or burn such an incense; or anoint his temples, or the soles of his feet, with such an ointment or oil: and you must choose, for the composition of such pill, perfume, or ointment, such ingredients as do make the spirits a little more gross or muddy; whereby the imagination will fix the better.

955. The body passive and to be wrought upon, (I mean not of the imaginant,) is better wrought upon (as hath been partly touched) at some times than at others: as if you should prescribe a servant about a sick person (whom you have possessed that his master shall recover) when his master is fast asleep, to use such a root, or such a root. For imagination is like to work better upon sleeping men than men awake; as we shall shew when we handle dreams.

956. We find in the art of memory, that images visible work better than other conceits: as if you would remember the word *philosophy*, you shall more surely do it by imagining that such a man (for men are best places) is reading upon Aristotle's Physics; than if you should imagine him to say, *I'll go study philosophy*. And therefore this observation would be translated to the subject we now speak of: for the more lustrous the imagination is, it filleth and fixeth the better. And therefore I conceive that you shall, in that experiment (whereof we spake before) of binding of thoughts, less fail, if you tell one that such an one shall name one of twenty men, than if it were one of twenty cards. The experiment of binding of thoughts would be diversified and tried to the full: and you are to note whether it hit for the most part, though not always.

957. It is good to consider upon what things imagination hath most force: and the rule (as I conceive) is, that it hath most force upon things that have the lightest and easiest motions. And therefore above all, upon the spirits of men; and in them, upon such affections as move lightest; as upon procuring of love; binding of lust, which is ever with imagination; upon men in fear; or men in irresolution; and the like. Whatsoever is of this kind would be thoroughly inquired. Trials likewise would be made upon plants, and that dili-

gently: as if you should tell a man, that such a tree would die this year; and will him at these and these times to go unto it, to see how it thriveth. As for inanimate things, it is true that the motions of shuffling of cards, or casting of dice, are very light motions: and there is a folly very usual, that gamesters imagine, that some that stand by them bring them ill luck. There would be trial also made of holding a ring by a thread in a glass, and telling him that holdeth it, before, that it shall strike so many times against the side of the glass, and no more; or of holding a key between two men's fingers, without a charm; and to tell those that hold it that at such a name it shall go off their fingers; for these two are extreme light motions. And howsoever I have no opinion of these things, yet so much I conceive to be true; that strong imagination hath more force upon things living, or that have been living, than things merely inanimate: and more force likewise upon light and subtile motions, than upon motions vehement or ponderous.

958. It is an usual observation, that if the body of one murthered be brought before the murtherer, the wounds will bleed afresh. Some do affirm, that the dead body, upon the presence of the murtherer, hath opened the eyes; and that there have been such like motions, as well where the party murthered hath been strangled or drowned, as where they have been killed by wounds. It may be that this participateth of a miracle, by God's just judgment, who usually bringeth murthers to light: but if it be natural, it must be referred to imagination.

959. The tying of the point upon the day of marriage, to make men impotent towards their wives, which (as we have formerly touched) is so frequent in Zant and Gascony, if it be natural, must be referred to the imagination of him that tieth the point. I conceive it to have the less affinity with witchcraft, because not peculiar persons only, (such as witches are,) but any body may do it.

Experiments in consort touching the secret virtue of sympathy and antipathy.

960. There be many things that work upon the spirits of man by secret sympathy and antipathy: the virtues of precious stones, worn, have been anciently and generally received, and

curiously assigned to work several effects. So much is true; that stones have in them fine spirits, as appeareth by their splendour; and therefore they may work by consent upon the spirits of men, to comfort and exhilarate them. Those that are the best for that effect, are the diamond, the emerald, the jacinth oriental, and the gold stone, which is the yellow topaz. As for their particular proprieties, there is no credit to be given to them. But it is manifest that light, above all things, excelleth in comforting the spirits of men: and it is very probable that light varied doth the same effect, with more novelty. And this is one of the causes why precious stones comfort. And therefore it were good to have tincted lanthorns, or tincted screens, of glass coloured into green, blue, carnation, crimson, purple, &c., and to use them with candles in the night. So likewise to have round glasses, not only of glass coloured through, but with colours laid between crystals, with handles to hold in one's hand. Prisms are also comfortable things. They have of Paris-work, looking-glasses bordered with broad borders of small crystal, and great counterfeit precious stones, of all colours, that are most glorious and pleasant to behold; especially in the night. The pictures of Indian feathers are likewise comfortable and pleasant to behold. So also fair and clear pools do greatly comfort the eyes and spirits; especially when the sun is not glaring, but overcast; or when the moon shineth.

961. There be divers sorts of bracelets fit to comfort the spirits; and they be of three intentions; refrigerant, corroborant, and aperient. For refrigerant, I wish them to be of pearl, or of coral, as is used; and it hath been noted that coral, if the party that weareth it be ill disposed, will wax pale; which I believe to be true, because otherwise distemper of heat will make coral lose colour. I commend also beads, or little plates of lapis lazuli; and beads of nitre, either alone or with some cordial mixture.

962. For corroboration and confortation, take such bodies as are of astringent quality, without manifest cold. I commend bead-amber; which is full of astriction, but yet is unctuous, and not cold; and is conceived to impinguate those that wear such beads; I commend also beads of hartshorn and ivory, which are of the like nature; also orange beads; also beads of lignum aloës, macerated first in rose-water, and dried.

963. For opening, I commend beads, or pieces of the roots of carduus benedictus: also of the roots of piony the male; and of orrice; and of calamus aromaticus; and of rue.

964. The cramp (no doubt) cometh of contraction of sinews; which is manifest, in that it cometh either by cold or dryness; as after consumptions, and long agues; for cold and dryness do (both of them) contract and corrugate. We see also that chafing a little above the place in pain, easeth the cramp; which is wrought by the dilatation of the contracted sinews by heat. There are in use for the prevention of the cramp, two things; the one rings of sea-horse teeth worn upon the fingers; the other bands of green periwinkle (the herb) tied about the calf of the leg, or the thigh, &c., where the cramp useth to come. I do find this the more strange, because neither of these have any relaxing virtue, but rather the contrary. I judge therefore that their working is rather upon the spirits within the nerves, to make them strive less, than upon the bodily substance of the nerves.

965. I would have trial made of two other kinds of bracelets, for comforting the heart and spirits: the one of the trochisch of vipers, made into little pieces of beads; for since they do great good inwards (especially for pestilent agues), it is like they will be effectual outwards, where they may be applied in greater quantity. There would be trochisch likewise made of snakes; whose flesh dried is thought to have a very opening and cordial virtue. The other is, of beads made of the scarlet powder which they call kermes; which is the principal ingredient in their cordial confection alkermes: the beads would be made up with ambergrise, and some pomander.

966. It hath been long received, and confirmed by divers trials, that the root of the male-piony dried, tied to the neck, doth help the falling sickness; and likewise the incubus, which we call the mare.[1] The cause of both these diseases, and especially of the epilepsy from the stomach, is the grossness of the vapours which rise and enter into the cells of the brain: and therefore the working is by extreme and subtile attenuation; which that simple hath. I judge the like to be in castoreum, musk, rue-seed, agnus castus seed, &c.

[1] Cardan (De Subtil. xviii. p. 641.) affirms that peony thus applied is good against gout, but he does not mention the falling sickness. But compare the same writer, *De Rer. Variet.* p. 172.

967. There is a stone which they call the blood-stone, which worn is thought to be good for them that bleed at the nose: which (no doubt) is by astriction and cooling of the spirits.[1] *Quære*, if the stone taken out of the toad's head be not of the like virtue; for the toad loveth shade and coolness.

968. Light may be taken from the experiment of the horse-tooth ring, and the garland of periwinkle, how that those things which assuage the strife of the spirits, do help diseases, contrary to the intention desired: for in the curing of the cramp, the intention is to relax the sinews; but the contraction of the spirits, that they strive less, is the best help: so to procure easy travails of women, the intention is to bring down the child; but the best help is, to stay the coming down too fast: whereunto they say the toad-stone likewise helpeth. So in pestilent fevers, the intention is to expel the infection by sweat and evaporation: but the best means to do it is by nitre, diascordium, and other cool things, which do for a time arrest the expulsion, till nature can do it more quietly. For as one saith prettily: *In the quenching of the flame of a pestilent ague, nature is like people that come to quench the fire of a house; which are so busy, as one of them letteth another.* Surely it is an excellent axiom, and of manifold use, that whatsoever appeaseth the contention of spirits, furthereth their action.

969. The writers of natural magic commend the wearing of the spoil of a snake, for preserving of health. I doubt it is but a conceit; for that the snake is thought to renew her youth by casting her spoil. They might as well take the beak of an eagle, or a piece of a hart's horn, because those renew.

970. It hath been anciently received, (for Pericles the Athenian used it,) and it is yet in use, to wear little bladders of quicksilver, or tablets of arsenic, as preservatives against the plague: not as they conceive, for any comfort they yield to the spirits, but for that being poisons themselves, they draw the venom to them from the spirits.[2]

[1] See Joyful News, &c., p. 18.

[2] I do not know where this is related of Pericles. Mercurialis, in his *De Venenis et Morbis venenosis*, ii. 9. (Venice, 1583), speaks of it as a recent invention, so that he at least did not believe that Pericles had employed it. Mercurialis was eminently learned in medical literature, so that his silence on this point deserves notice. Straussius affirms that Carpi, who died in 1550, is the first writer who mentions the practice, but that it appears to have been common in Turkey at an earlier time. See Straussius, *Epist. ad Comit. Digbæum* (Kenelm Digby), in the *Theatrum Sympatheticum*, p. 136., and for a full account of all arsenical and other amulets Isbrand de

971. Vide the experiments 95, 96, and 97, touching the several sympathies and antipathies for medicinal use.

972. It is said that the guts or skin of a wolf, being applied to the belly, do cure the colic.[1] It is true, that the wolf is a beast of great edacity and digestion; and so, it may be, the parts of him comfort the bowels.

973. We see scare-crows are set up to keep birds from corn and fruit. It is reported by some that the head of a wolf, whole, dried, and hanged up in a dove-house, will scare away vermin; such as are weasels, polecats, and the like. It may be the head of a dog will do as much; for those vermin with us, know dogs better than wolves.

974. The brains of some creatures (when their heads are roasted) taken in wine, are said to strengthen the memory; as the brains of hares, brains of hens, brains of deers, &c. And it seemeth to be incident to the brains of those creatures that are fearful.[2]

975. The ointment that witches use is reported to be made of the fat of children digged out of their graves; of the juices of smallage, wolf-bane, and cinque-foil, mingled with the meal of fine wheat. But I suppose that the soporiferous medicines are likest to do it; which are henbane, hemlock, mandrake, moonshade, tobacco, opium, saffron, poplar-leaves, &c.

976. It is reported by some that the affections of beasts, when they are in strength, do add some virtue unto inanimate things; as that the skin of a sheep devoured by a wolf, moveth itching; that a stone bitten by a dog in anger, being thrown at him, drunk in powder, provoketh choler.

977. It hath been observed that the diet of women with child doth work much upon the infant; as if the mother eat quinces much, and coriander-seed, (the nature of both which is to repress and stay vapours that ascend to the brain,) it will

Diemerbroeck, *De Peste*, ii. 11., who refers to a great number of writers. I may add to those he has mentioned, Cæsalpinus, *De Rebus Metallicis*, i. 30., and Septalius *De Peste*. [Bacon was perhaps thinking of the charm which Pericles wore about his neck when he was ill of the plague; which is mentioned by Plutarch, on the authority of Theophrastus.—*J. S.*]

[1] Cardan, De Subtil. xviii. p. 639. Almost all the statements in the succeeding paragraphs, to 980. inclusive, are taken from Cardan. See the *De Subtil.* p. 639. to p. 641.

[2] It seems difficult to understand why the brain of one animal should have more effect than that of another, but as phosphorus appears to exist in a peculiar state in the brain, it is quite possible that in cases in which a failure of memory arises from deficient nutrition of the organ (assuming that there are such cases), the diet mentioned in the text might be useful.

make the child ingenious; and on the contrary side, if the mother eat (much) onions or beans, or such vaporous food; or drink wine or strong drink immoderately; or fast much; or be given to much musing; (all which send or draw vapours to the head;) it endangereth the child to become lunatic, or of imperfect memory: and I make the same judgment of tobacco often taken by the mother.

978. The writers of natural magic report that the heart of an ape, worn near the heart, comforteth the heart, and increaseth audacity. It is true that the ape is a merry and bold beast. And that the same heart likewise of an ape, applied to the neck or head, helpeth the wit; and is good for the falling sickness: the ape also is a witty beast, and hath a dry brain; which may be some cause of attenuation of vapours in the head. Yet it is said to move dreams also. It may be the heart of a man would do more, but that it is more against men's minds to use it; except it be in such as wear the reliques of saints.

979. The flesh of a hedge-hog, dressed and eaten, is said to be a great drier: it is true that the juice of a hedge-hog must needs be harsh and dry, because it putteth forth so many prickles: for plants also that are full of prickles are generally dry; as briars, thorns, berberries; and therefore the ashes of a hedge-hog are said to be a great desiccative of fistulas.

980. Mummy hath great force in stanching of blood; which, as it may be ascribed to the mixture of balms that are glutinous; so it may also partake of a secret propriety; in that the blood draweth man's flesh. And it is approved that the moss which groweth upon the skull of a dead man unburied, will stanch blood potently: and so do the dregs, or powder of blood, severed from the water, and dried.

981. It hath been practised, to make white swallows, by anointing of the eggs with oil.[1] Which effect may be produced by the stopping of the pores of the shell, and making the juice, that putteth forth the feathers afterwards, more penurious. And it may be, the anointing of the eggs will be as effectual as the anointing of the body; of which vide the experiment 93.

982. It is reported that the white of an egg, or blood, mingled with salt-water, doth gather the saltness, and maketh

[1] Cardan, De Rerum Varietate, xvi. 90. p. 811.

the water sweeter. This may be by adhesion; as in the sixth experiment of clarification: it may be also, that blood, and the white of an egg, (which is the matter of a living creature,) have some sympathy with salt: for all life hath a sympathy with salt. We see that salt laid to a cut finger healeth it; so as it seemeth salt draweth blood, as well as blood draweth salt.

983. It hath been anciently received that the sea-hare hath an antipathy with the lungs, (if it cometh near the body,) and erodeth them. Whereof the cause is conceived to be, a quality it hath of heating the breath and spirits; as cantharides have upon the watery parts of the body, as urine and hydropical water. And it is a good rule, that whatsoever hath an operation upon certain kinds of matters, that, in man's body, worketh most upon those parts wherein that kind of matter aboundeth.

984. Generally, that which is dead, or corrupted, or excerned, hath antipathy with the same thing when it is alive, and when it is sound[1]; and with those parts which do excern: as a carcase of man is most infectious and odious to man; a carrion of an horse to an horse, &c.; purulent matter of wounds, and ulcers, carbuncles, pocks, scabs, leprosy, to sound flesh; and the excrement of every species to that creature that excerneth them. But the excrements are less pernicious than the corruptions.

985. It is a common experience, that dogs know the dog-killer; when, as in times of infection, some petty fellow is sent out to kill the dogs; and that, though they have never seen him before, yet they will all come forth, and bark, and fly at him.

986. The relations touching the force of imagination and the secret instincts of nature, are so uncertain, as they require a great deal of examination ere we conclude upon them. I would have it first throughly inquired, whether there be any secret passages of sympathy between persons of near blood; as parents, children, brothers, sisters, nurse-children, husbands, wives, &c. There be many reports in history, that upon the death of persons of such nearness, men have had an inward feeling of it. I myself remember, that being in Paris, and my father dying in London, two or three days before my father's death I had a dream, which I told to divers English gentlemen, that my

[1] "Horret enim omne simile maxime simile cum corruptum est."—*Cardan, De Subtil.* p. 641.

father's house in the country was plastered all over with black mortar. There is an opinion abroad, (whether idle or no I cannot say,) that loving and kind husbands have a sense of their wives breeding child, by some accident in their own body.

987. Next to those that are near in blood, there may be the like passage and instincts of nature between great friends and enemies: and sometimes the revealing is unto another person, and not to the party himself. I remember Philippus Comineus (a grave writer) reporteth, that the Archbishop of Vienna (a reverend prelate) said one day after mass to King Lewis the eleventh of France: *Sir, your mortal enemy is dead;* what time Charles Duke of Burgundy was slain at the battle of Granson against the Switzers.[1] Some trial also would be made, whether pact or agreement do any thing; as if two friends should agree, that such a day in every week, they, being in far distant places, should pray one for another, or should put on a ring or tablet one for another's sake; whether if one of them should break their vow and promise, the other should have any feeling of it in absence.

988. If there be any force in imaginations and affections of singular persons, it is probable the force is much more in the joint imaginations and affections of multitudes: as if a victory should be won or lost in remote parts, whether is there not some sense thereof in the people whom it concerneth; because of the great joy or grief that many men are possessed with at once? Pius Quintus, at the very time when that memorable victory was won by the Christians against the Turks, at the naval battle of Lepanto, being then hearing of causes in the consistory, brake off suddenly, and said to those about him, *It is now more time we should give thanks to God*

[1] Charles the Bold was not killed at Granson, but at Nancy; nor is the story told by Philippe de Comines. We have no authority for it but that of the anonymous author of an account of Angelo Caltho, Archbishop of Vienne, to whom Comines inscribed his memoirs. This account is prefixed to several editions of them, and first, I believe, to that which Sauvage published in 1605. In truth, Comines' silence is, as Bayle remarks, almost conclusive against the story, and it is remarkable that Bacon should have ascribed it to him, as Sauvage, whose edition Bacon probably used, notes in the margin that it is odd that Comines should have omitted so singular an incident. Caltho is called Cato in Madile. Dupont's edition of Comines. He was a native of Tarento, and was a long time in the service of the Duke of Burgundy, whom he deserted after the defeat at Granson. A similar story is told with respect to Richard Cœur de Lion, — that his death was announced at Rome on the day it happened, by a bishop whom he had deprived of his see. "Telum Limogiæ," said the bishop, interrupting himself while he was performing mass, "occidit Leonem Angliæ."

for the great victory he has granted us against the Turks: it is true that victory had a sympathy with his spirit; for it was merely his work to conclude that league.[1] It may be that revelation was divine: but what shall we say then to a number of examples amongst the Grecians and Romans? where the people being in theatres at plays, have had news of victories and overthrows, some few days before any messenger could come.

It is true that that may hold in these things, which is the general root of superstition; namely, that men observe when things hit, and not when they miss; and commit to memory the one, and forget and pass over the other. But touching divination, and the misgiving of minds, we shall speak more when we handle in general the nature of minds, and souls, and spirits.

989. We have given formerly some rules of imagination; and touching the fortifying of the same. We have set down also some few instances and directions, of the force of imagination upon beasts, birds, &c.; upon plants; and upon inanimate bodies: wherein you must still observe, that your trials be upon subtile and light motions, and not the contrary; for you will sooner by imagination bind a bird from singing than from eating or flying; and I leave it to every man to choose experiments which himself thinketh most commodious; giving now but a few examples of every of the three kinds.

990. Use some imaginant, (observing the rules formerly prescribed,) for binding of a bird from singing; and the like of a dog from barking. Try also the imagination of some, whom you shall accommodate with things to fortify it, in cock-fights, to make one cock more hardy and the other more cowardly. It would be tried also in flying of hawks; or in coursing of a deer, or hart, with grey-hounds; or in horse-races; and the like comparative motions; for you may sooner by imagination quicken or slack a motion, than raise or cease it; as it is easier to make a dog go slower, than to make him stand still that he may not run.

[1] This story rests upon better authority than most stories of the same kind. Catena tells it in his Life of Pius V., published in 1586, only fourteen years after the battle. The Pope was not engaged in hearing causes, but in transacting affairs of state with his minister Bussoti. See Catena, *Vita di Pio V.* p. 195. Cardinal de Perron mentions it as a thing which everybody at Rome knew to be true.

991. In plants also, you may try the force of imagination upon the lighter sort of motions: as upon the sudden fading, or lively coming up of herbs; or upon their bending one way or other; or upon their closing and opening, &c.

992. For inanimate things, you may try the force of imagination upon staying the working of beer when the barm is put in; or upon the coming of butter or cheese, after the churning [1], or the rennet be put in.

993. It is an ancient tradition every where alleged, for example of secret proprieties and influxes, that the torpedo marina, if it be touched with a long stick, doth stupefy the hand of him that toucheth it. It is one degree of working at distance, to work by the continuance of a fit medium; as sound will be conveyed to the ear by striking upon a bow-string, if the horn of the bow be held to the ear.

994. The writers of natural magic do attribute much to the virtues that come from the parts of living creatures; so as they be taken from them, the creatures remaining still alive [2]: as if the creature still living did infuse some immateriate virtue and vigour into the part severed. So much may be true; that any part taken from a living creature newly slain, may be of greater force than if it were taken from the like creature dying of itself, because it is fuller of spirit.

995. Trial would be made of the like parts of individuals in plants and living creatures; as to cut off a stock of a tree, and to lay that which you cut off to putrefy, to see whether it will decay the rest of the stock: or if you should cut off part of the tail or leg of a dog or a cat, and lay it to putrefy, and so see whether it will fester, or keep from healing, the part which remaineth.

996. It is received, that it helpeth to continue love, if one wear a ring, or a bracelet, of the hair of the party beloved. But that may be by the exciting of the imagination: and perhaps a glove, or other like favour, may as well do it.

997. The sympathy of individuals, that have been entire, or have touched, is of all others the most incredible; yet according unto our faithful manner of examination of nature, we will make some little mention of it. The taking away of warts, by rubbing them with somewhat that afterwards is put to waste

[1] *charming* in the original. — *J. S.*

[2] Porta, Natural Magic, l. 14.

and consume, is a common experiment; and I do apprehend it the rather, because of mine own experience. I had, from my childhood, a wart upon one of my fingers: afterwards, when I was about sixteen years old, being then at Paris, there grew upon both my hands a number of warts (at the least an hundred) in a month's space. The English ambassador's lady, who was a woman far from superstition, told me one day, she would help me away with my warts: whereupon she got a piece of lard, with the skin on, and rubbed the warts all over with the fat side; and amongst the rest, that wart which I had had from my childhood: then she nailed the piece of lard, with the fat towards the sun, upon a post of her chamber window, which was to the south. The success was, that within five weeks' space all the warts went quite away: and that wart which I had so long endured, for company. But at the rest I did little marvel, because they came in a short time, and might go away in a short time again: but the going away of that which had stayed so long, doth yet stick with me. They say the like is done by rubbing of warts with a green elder stick, and then burying the stick to rot in muck. It would be tried with corns and wens, and such other excrescences. I would have it also tried with some parts of living creatures that are nearest the nature of excrescences; as the combs of cocks, the spurs of cocks, the horns of beasts, &c. And I would have it tried both ways; both by rubbing those parts with lard, or elder, as before; and by cutting off some piece of those parts, and laying it to consume; to see whether it will work any effect towards the consumption of that part which was once joined with it.

998. It is constantly received and avouched, that the anointing of the weapon that maketh the wound, will heal the wound itself. In this experiment, upon the relation of men of credit, (though myself, as yet, am not fully inclined to believe it,) you shall note the points following. First, the ointment wherewith this is done is made of divers ingredients; whereof the strangest and hardest to come by, are the moss upon the skull of a dead man unburied, and the fats of a boar and a bear killed in the act of generation. These two last I could easily suspect to be prescribed as a starting-hole; that if the experiment proved not, it might be pretended that the beasts were not killed in the due time: for as for the moss, it is certain there is great quantity of it in Ireland, upon slain bodies, laid on heaps unburied. The

other ingredients are, the blood-stone in powder, and some other things, which seem to have a virtue to stanch blood; as also the moss hath. And the description of the whole ointment is to be found in the chemical dispensatory of Crollius.[1] Secondly, the same kind of ointment applied to the hurt itself worketh not the effect; but only applied to the weapon. Thirdly, (which I like well,) they do not observe the confecting of the ointment under any certain constellation; which commonly is the excuse of magical medicines when they fail, that they were not made under a fit figure of heaven. Fourthly, it may be applied to the weapon, though the party hurt be at great distance. Fifthly, it seemeth the imagination of the party to be cured is not needful to concur; for it may be done without the knowledge of the party wounded: and thus much hath been tried, that the ointment (for experiment's sake) hath been wiped off the weapon, without the knowledge of the party hurt, and presently the party hurt hath been in great rage of pain, till the weapon was re-anointed. Sixthly, it is affirmed that if you cannot get the weapon, yet if you put an instrument of iron or wood, resembling the weapon, into the wound, whereby it bleedeth, the anointing of that instrument will serve and work the effect. This I doubt should be a device to keep this strange form of cure in request and use; because many times you cannot come by the weapon itself. Seventhly, the wound must be at first washed clean with white wine, or the party's own water; and then bound up close in fine linen, and no more dressing renewed till it be whole. Eighthly, the sword itself must be wrapped up close, as far as the ointment goeth, that it taketh no wind. Ninthly, the ointment, if you wipe it off from the sword and keep it, will serve again; and rather increase in virtue than diminish. Tenthly, it will cure in far shorter time than ointments of wounds commonly do. Lastly, it will cure a beast, as well as a man; which I like best of all the rest, because it subjecteth the matter to an easy trial.

Experiment solitary touching secret proprieties.

999. I would have men know, that though I reprehend the easy passing over of the causes of things, by ascribing them to secret and hidden virtues and proprieties; (for this hath arrested

[1] See his *Basilica Chymica*, p. 400. In the edition I have seen, that of 1643, nothing is said as to the time of killing the bear and the boar. On the subject of "unguenta armaria," see a collection of tracts in the *Theatrum Sympatheticum*.

and laid asleep all true inquiry and indications;) yet I do not understand but that in the practical part of knowledge, much will be left to experience and probation, whereunto indication cannot so fully reach: and this not only in *specie*, but in *individuo*. So in physic, if you will cure the jaundice [1], it is not enough to say that the medicine must not be cooling; for that will hinder the opening which the disease requireth: that it must not be hot; for that will exasperate choler: that it must go to the gall; for there is the obstruction which causeth the disease, &c. But you must receive from experience, that powder of Chamæpitys, or the like, drunk in beer, is good for the jaundice.[2] So again, a wise physician doth not continue still the same medicine to a patient; but he will vary, if the first medicine doth not apparently succeed: for of those remedies that are good for the jaundice, stone, agues, &c., that will do good in one body which will not do good in another; according to the correspondence the medicine hath to the individual body.

Experiment solitary touching the general sympathy of men's spirits.

1000. The delight which men have in popularity, fame, honour, submission and subjection of other men's minds, wills, or affections, (although these things may be desired for other ends,) seemeth to be a thing in itself, without contemplation of consequence, grateful and agreeable to the nature of man. This thing (surely) is not without some signification, as if all spirits and souls of men came forth out of one divine limbus; else why should men be so much affected with that which others think or say? The best temper of minds desireth good name and true honour: the lighter, popularity and applause: the more depraved, subjection and tyranny; as is seen in great conquerors and troublers of the world; and yet more in arch-heretics; for the introducing of new doctrines is likewise an affectation of tyranny over the understandings and beliefs of men.

[1] *jaundies* in the original.—*J. S.*

[2] See Pliny. xxiv. 20.

A

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Of the Secret Virtue of Sympathy and Antipathy - - 660
Of Secret Virtues and Proprieties - - - - 671
Of the General Sympathy of Men's Spirits - - - 672

NOTE.

I have not been able to procure a copy of the first edition of the *Sylva Sylvarum*, which was published in 1627. Wherever therefore I speak of "the original," I must be understood to refer to the *second* edition, which appeared in 1628. The same remark will apply to the *New Atlantis*, in the next volume. — *J. S.*

SCALA INTELLECTUS.

PREFACE

TO THE

SCALA INTELLECTUS AND PRODROMI.

THE two following pieces (which complete the first part of the Philosophical Works) were first published by Gruter in 1653. They are not included in Dr. Rawley's *Opuscula* (1658), nor mentioned in his list of Bacon's later writings. As to the date of their composition, I can find no grounds even for a guess. Either of them might apparently have been written at any time after the plan of the *Instauratio* in its six parts had been once conceived. Gruter places them among what he calls *Impetus Philosophici;* which merely means that they came to him as loose sheets without any direction under what title to arrange them. There can be no doubt however that they were intended as prefaces to the fourth and fifth parts of the *Instauratio* respectively; nor is there any reason to suppose that they had been either abandoned or superseded. Being unable therefore to follow the order of composition, I follow the order of matter, and put them here where they were meant ultimately to stand.

With these prefaces the collection of works published or designed for publication as parts of the *Instauratio Magna* must close. Of the fourth part not even any fragment has come down to us, unless the *Inquisitio legitima de Motu, sive Filum Labyrinthi,* be taken for one. But though this was undoubtedly intended to be "veræ et legitimæ de rebus inquisitionis *exemplar,*"—and such it was the business of the fourth part to exhibit,—I rather think that it was designed originally for the *second* part (as the example in which the new method was to be set forth), and that the *Inquisitio de Formâ Calidi* was

substituted for it. I have preferred therefore to place it among the works abandoned or superseded.

With regard to the fifth part however, I am not so confident that Mr. Ellis is right in refusing a place in it to the *De Fluxu et Refluxu*, the *Thema Cœli*, the *De Principiis atque Originibus*, and the *Cogitationes de Naturâ Rerum;* all which he classes as "occasional writings, not belonging to the circuit of the *Instauratio.*" It is true that they were written long before the publication of the *Novum Organum*, and that they do not come within the circuit of Bacon's work on the Interpretation of Nature as originally projected. That work (to judge by the title, which has fortunately been preserved) was to be distributed into three books, the first to prepare the mind, the second to explain the method, the third to exhibit the results of the method applied. It must therefore have been designed to cover the ground occupied by the second and sixth parts of the *Instauratio*, and perhaps also that occupied by the third and fourth; but could not have been meant to contain anything answering to the first and fifth. My own impression however is, that one of Bacon's objects in enlarging the design was to make a place in the great structure for occasional writings of this kind, which could not have properly come into any of those three books originally planned. The addition of the third and fourth parts indeed, — that is, the assigning of a separate part to the *Phænomena Universi*, and a separate part to the *Scala Intellectus*, — may be regarded as a development merely of the original idea; for the exposition of the new method could not be complete without at least one perfect example of an inquiry legitimately conducted through all the processes and ending in the discovery of the *form;* nor could such an example be exhibited without a specimen of the "historia naturalis et experimentalis quæ sit in ordine ad condendam philosophiam," in reference at least to that one subject. But the matter to be contained in the first and fifth was avowedly extraneous to the main design; and the addition of these is most easily accounted for by supposing that in prefixing the first, Bacon meant to make a place for the *Advancement of Learning* and for a variety of miscellaneous works not bearing on natural philosophy; and in interpolating the fifth, for sundry philosophical speculations which his studies had suggested to him, and which he regarded as guesses worth pre-

serving; though, being no better than "anticipationes mentis," —conclusions derived through an imperfect logical machinery from imperfect knowledge,—they were to be looked upon as provisional only, and by no means as specimens of the *Philosophia Secunda.*

If there be any truth in this conjecture, the pieces which I have mentioned have a fair claim to a place among the *Prodromi,* and might follow the preface. In deference however to Mr. Ellis's judgment I have placed them in a class by themselves. If any reader prefers to regard them as belonging to the *Instauratio,* he has only to pass to the next volume, overlook the titlepage, and read on.

This collection of the fragments of the Great Instauration as Bacon left it could hardly however have been concluded more appropriately than with the two short pieces which follow; in which we see the vision which suggested the enterprise, the grounds of reason which seemed to justify it as sober and practicable, the hope which sustained and the spirit which regulated it, still as fresh as when he started; but the end as far off as ever, and all the laborious preparations for the future harvest breaking off abruptly in a reiteration of the exhortations, warnings, and promises, with which they were commenced.

Atque opere in medio defixa reliquit aratra!

J. S.

SCALA INTELLECTUS

SIVE

FILUM LABYRINTHI.

DIFFICILIS sane foret reprehensio eorum quibus *nihil sciri* placuit, si decretum durum interpretatione molliore correxissent. Si quis enim asserat, hoc ipsum scire, recte acceptum, esse per causas scire; causarum autem cognitionem gliscere, et serie et veluti catena perpetua ad notissima naturæ scandere, adeo ut particularium rerum cognitio, absque exacta universæ naturæ comprehensione, proprie non absolvatur; non facile invenias quod sano cum judicio contradici possit. Nam et veram alicujus rei scientiam haberi posse antequam mens in causarum explicatione plane consistat, minus consentaneum; et perfectam universi cognitionem humanæ naturæ attribuere atque asserere, temerarium fortasse quiddam atque impotentis cujusdam animi censeri possit. Verum illi contra, nulla hujusmodi usi interpretatione aut moderatione, sensuum oracula prorsus profanare non veriti sunt; quod cum summa rerum desperatione conjunctum est. Quod si verum omnino dicendum sit; etiamsi ab hac calumnia abstinuissent, tamen hæc ipsa lis intempestive et contentiose mota videatur; cum citra istam quam intelligere videntur ipsissimam veritatem tantus humanæ industriæ pateat campus, ut sit res præpostera et quasi mentis commotæ et perturbatæ, de extremis obtinendis solicitum tantas in medio sitas utilitates prætermittere. Nam utcunque per *veri* et *probabilis* distinctionem, scientiæ certitudinem destruere, usum retinere, videri volunt; atque, quoad activam partem, delectum rerum illæsum relinquere; tamen, sublata ex animis hominum veritatis exquirendæ spe, proculdubio nervos inquisitioni humanæ inciderunt, et promiscua quærendi

licentia, inveniendi negotium in exercitationem quandam ingenii et disputationis verterunt. Veruntamen negare plane non possumus, quin si qua nobis cum antiquis intercedat societas, ea cum hoc genere philosophiæ maxime conjuncta sit; cum multa ab illis de sensuum variationibus et judicii humani infirmitate et de cohibendo et sustinendo assensu prudenter dicta et animadversa probemus; quibus etiam in numera alia, quæ eodem pertinent, adjungere possemus; adeo ut inter nos et illos hoc tantum intersit, quod illi nil vere sciri posse prorsus, nos nil vere sciri posse ea qua adhuc gens humana ingressa est via, statuamus. Neque vero hujus societatis nos pudet. Si enim in hunc cœtum recipiantur non solum ii qui sententia et placito hoc tenent et opinantur, sed et illi qui idem aut forma ipsa interrogandi et objiciendi præ se ferunt, aut conquerendo de rerum obscuritate et indignando fatentur et quasi clamant, aut secreto animo agitant et raris et occultis vocibus veluti insusurrant, invenias in hoc numero viros ex antiquis longe maximos, et contemplationum principes, in quorum consortium includi neminem pœniteat. Pronuntiandi enim confidentiam fortasse unus aut alter ex antiquis usurpavit; neque tamen invaluit ea ipsa, nisi haud ita pridem barbaris seculis; nunc autem factione quadam, atque consuetudine et incuria, retinetur. Sed tamen rursus in hac de qua diximus societate facile quis perspexerit, nos erga illos viros initiis opinionum conjunctos, exitu in immensum divisos esse. Etsi enim primo non multum dissentire videamur, quod illi incompetentiam humani intellectus simpliciter, nos sub modo asseramus; nihilominus huc res redit, ut illi, nullum huic malo remedium invenientes aut sperantes, negotium deserant; et sensus certitudinem invadendo, scientiam ab imis fundamentis evertant: nos, novam viam afferentes, tum sensus tum mentis errores regere et restituere conemur. Itaque illi, jactam arbitrati aleam, ad ingenii quandam peregrinationem liberam et amœnam se vertunt: nobis ex opinione nostra difficilis et remota obvenit provincia, quæ ut generi humano felix et fausta sit perpetuo precamur. Itaque initia viarum secundo libro descripsimus; easdem ipsi continuo ingressi[1], tertio Phænomena Universi et Historiam tractavimus; in quo certe sylvas naturæ, et variatione infinita experimentorum veluti foliis opacas et

[1] The original has a full stop after *ingressi*. I have followed the example of M. Bouillet in substituting a comma. — *J. S.*

obscuras, et observationum subtilitate veluti virgultis et vepribus implicatas, penetravimus et præterivimus. Atque nunc ad magis aperta fortasse sed tamen ad magis ardua pervenimus, ex sylvis scilicet ad radices montium. Nam ab historia ad universalia certo atque constanti tramite (licet via nova et intentata) ducemus. Atque certe non male in vias contemplationum conveniret illud celebre et decantatum apud antiquos bivium vitæ activæ; ex quo via altera, primo ingressu plana et facilis, ducebat ad prærupta et impervia; altera, a principio ardua et suspensa, in plana desinebat.[1] Nam eodem prorsus modo, qui jam inde a prima inquisitione immobilia quædam in scientiis principia prensabit, quibus acquiescens cætera veluti per otium expediat; illum, si modo perrexerit nec nimium sibi placens aut displicens ab inquisitione destiterit, prioris viæ fortuna manet. Qui autem judicium cohibere, et gradatim adscendere, et rerum veluti montium juga, unum primo, deinde alterum ac rursus alterum, superare, cum patientia vera et indefessa sustinuerit; ille ad summitates et vertices naturæ mature perveniet, ubi et statio serena et pulcherrimus rerum prospectus et descensus molli clivo ducens ad omnes practicas. Itaque consilium nostrum est, veræ et legitimæ de rebus inquisitionis, ut in secundo libro præcepta, ita hic exemplaria proponere et describere pro varietate subjectorum; idque ea forma, quam cum veritate summum consensum habere putamus, atque ut probatam et electam tradimus. Neque tamen, more apud homines recepto, omnibus hujus formulæ partibus necessitatem quandam attribuimus, tanquam unicæ essent et inviolabiles. Neque enim hominum industriam et felicitatem veluti ad columnam alligandas existimamus. Atque nihil officit, quo minus ii qui otio magis abundant, aut a difficultatibus quas primo experientem sequi necesse est liberi jam erunt, rem monstratam in potius perducant. Quin contra, artem veram adolescere statuimus.[2]

[1] Hesiod. Oper. 287.

[2] So in the original. Possibly the manuscript was imperfect at the end, and the sentence completed by conjecture: for this can hardly be what Bacon wrote. The aphorism is repeated in many places, and always in the form *artem inveniendi cum ingentis adolescere*. See the end of the first book of the *Novum Organum*. — *J. S.*

PRODROMI

sive

ANTICIPATIONES PHILOSOPHIÆ SECUNDÆ.

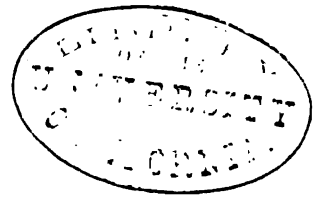
PRÆFATIO.

Existimamus eum et amantis civis et viri prudentis personam bene simul sustinuisse, qui interrogatus an optimas leges suis civibus dedisset, optimas certe, dixit, ex iis quas illi accepturi fuissent.[1] Atque certe quibus non tantum bene cogitasse satis est (quod non multo secus est ac bene somniasse) nisi obtineant quoque et rem ad effectum perducant, iis non optima utique, sed ex iis quæ probari verisimile est potissima, quandoque eligenda sunt. Nobis vero, licet Humanam Rempublicam, patriam communem, summo prosequamur amore, tamen legislatoria illa ratione et delectu uti liberum non est. Neque enim leges intellectui aut rebus damus ad arbitrium nostrum, sed tanquam scribæ fideles ab ipsius naturæ voce latas et prolatas excipimus et describimus. Itaque sive illæ placeant, sive per opinionum suffragia antiquentur, fides nostra omnino exsolvenda est. Neque tamen spem abjecimus, quin sint atque exoriantur apud posteros nonnulli, qui optima quæque capere et concoquere possint, et quibus ea perficere et colere curæ erit. Itaque ad illa ipsa tendere, atque fontes rerum et utilitatum aperire, et viarum indicia undique conquirere (invocata Numinis ope), nunquam dum in vivis erimus desistemus. Iidem nos, de eo quod ad omnes pertinere et in commune prodesse possit soliciti, dum ad majora contendimus, minora non aspernamur (cum illa remota, hæc parata esse soleant), nec potiora (ut arbitramur) afferentes, idcirco veteribus ac receptis, quominus illa apud plurimos valeant, intercedimus;

[1] Diog. Laert. in Sol.

quinetiam ea ipsa et aucta et emendata et in honore esse cupimus. Neque enim homines aut omnes aut omnino aut statim a receptis et creditis abducere conamur. Sed quemadmodum sagitta aut missile fertur certe in processu, sed tamen interim conversiones suas perpetuo expedit, progrediendo et nihilominus rotando; ita et nos, dum ad ulteriora rapimur, in receptis et cognitis volvimur et circumferimur. Quamobrem nos quoque rationis ipsius communis et demonstrationum vulgarium (abdicato licet imperio earum) honesta opera utimur; atque ea quæ nobis secundum eas inventa et judicata sunt, quæque plurimum et veritatis et utilitatis habere possunt, pari cum cæteris jure proponemus. Sed tamen neque per hoc iis quæ de rationis nativæ et demonstrationum veterum incompetentia dicta sunt derogatum quidquam intelligimus. Quin hæc potius adjunximus ad tempus, et in gratiam eorum qui justa excusatione aut virium aut occupationum retardati contemplationes suas intra veteres scientiarum plagas et provincias, aut saltem earum confinia contermina, sistere volent. Eadem iis qui veram naturæ interpretationem secundum indicia nostra accedent, eamque molientur, loco diverticulorum aut tabernaculorum in via præbitorum ad solatium et levamentum esse queant; atque interim humanas fortunas aliqua ex parte juvare, et mentes cogitationibus quæ paulo arctiorem cognationem habeant cum natura perfundere. Id vero ex facultate aliqua nostra, aut ejus fiducia, minime ominamur. Verum nobis dubium non est, si quis mediocris licet ingenii, sed tamen animi maturus, idola mentis suæ deponere atque inquisitionem de integro sibi decernere atque inter vera historiæ naturalis atque ejus calculos attente et diligenter et libere versari velit et possit; quin ille ipse, quisquis sit, longe altius in naturam penetraturus sit ex sese, et propriis et genuinis mentis viribus, denique ex meris Anticipationibus suis, quam per omnigenam authorum lectionem, aut meditationem abstractam infinitam, aut disputationes assiduas et repetitas; etsi machinas non admoverit, nec interpretandi formam secutus fuerit. Quare et simile quippiam nobis usu venire posse non diffidimus; præsertim cum accedat interpretandi experimentum et exercitatio, quam ipsum habitum mentis corrigere et mutare probabile est. Neque tamen hæc in eam partem accipi volumus, ac si fidem quam antiquorum placitis denegavimus nostris adhiberi postulemus. Quin contra testamur et profitemur,

nos ipsos istis quæ jam proponemus, qualiacunque ea sint, teneri minime velle, ut omnia Philosophiæ nostræ Secundæ et Inductivæ tamquam integra serventur. Cogitata autem ipsa spargere, non methodo revincire, visum est. Hæc enim forma pubescentibus tamquam a stirpe de integro scientiis debetur; atque ejus est, qui non artem constituere ex connexis, sed inquisitionem liberam instituere in singulis, in præsentia tantum velit.



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